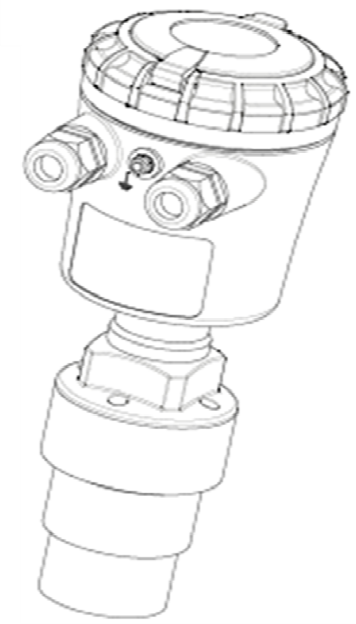
Gauger*420*
User Manual



You Can Measure the Solid Benefits…

Notices and safety guidelines

This manual is delivered subject to the following conditions and restrictions:

- The manual contains proprietary information belonging to Solid Applied Technologies Ltd. The information is published solely for the purpose of assisting authorized users of **Gauger***420*.
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- The text and graphics in this manual are for the purpose of illustration and reference only.
- Information included in this manual is subject to change without notice. Information in the manual may contain inaccuracies. Specifications are based on laboratory test results which are performed under tightly controlled environment. Field performance may vary from laboratory test results. We always welcome suggestions and recommendations from the users of our manuals.
- All company names, brand products and service names that may appear in this manual are trademarks or registered trademarks of their respective holders.
- Solid Applied Technologies shall not be liable for any loss or damage caused by the use of this manual or of products described in the manual. Solid Applied Technologies sole warranty is that products sold by the company shall be free of defects in material and in workmanship for a period of 12 months.
- **Gauger***420* must be installed, connected and operated in accordance with the instructions of this manual and with the **Gauger***420* certifications. Specific local regulations may also apply.
- Do not open or disassemble **Gauger***420* except as required for electrical connections.
- Any type of modifications and repairs are permissible only upon the manufacturer or re-seller written approval and by pre-qualified personal. Never reuse defective parts.

Date	Revision	Software version	Part number
Jan 2012	1.12	Gauger420 3.12	Gauger420

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I. Introduction

1. Description

Gauger*420* is a mono-block, 2-wire, ultrasonic level meter with integrated 4-20 current loop and USB interface for configuration and firmware upgrade. Optional items include display, HART protocol, external temperature sensor, dry contact input and output.

Gauger*420* measures distance. Targets may be liquid or solids. Measurement is continuous and does not require contact with the target. The system can accurately measure steady or agitated target surfaces. The system can also rapidly track filling and emptying of vessels. The system measurement distance spans 15 cm to 8 meters. In addition to distance, **Gauger***420* also measures temperature of the environment.

Gauger*420* makes use of the measured distance to calculate additional variables of importance. These variables include target level, target volume and optional Open Channel Flow.

Gauger*420 o*perates at an ultrasonic frequency of 75KHZ (optional 50 KHz) and is robust in noisy conditions. The sensor is made of PVDF – providing good chemical resistance to corrosive targets.

Gauger*420* is fed from 24VDC power and may be fed by other sources as long as 18VDC is measured on **Gauger***420* terminals. Measured data is reported over a 4-20mA current loop. Both 4mA and 20mA end points may be set independently and may support both upward and downward trends. In addition, data may be presented on a local display or transmitted over a HART protocol (optional).

Gauger*420* is equipped with a large graphic display and keypad allowing a simple wizard-driven setup of the system. The keypad and display allow configuration of many **Gauger***420* configuration parameters. Complete setup of all **Gauger***420* parameters can be executed using a USB equipped PC or laptop. This method of configuration supports rapid cloning of many **Gauger***420* systems. The setup is performed outside the 4-20 loop.

This user manual is intended for users and operators of **Gauger***420*. The manual covers system description, installation, operation and troubleshooting of **Gauger***420*.

2. Gauger420 parts

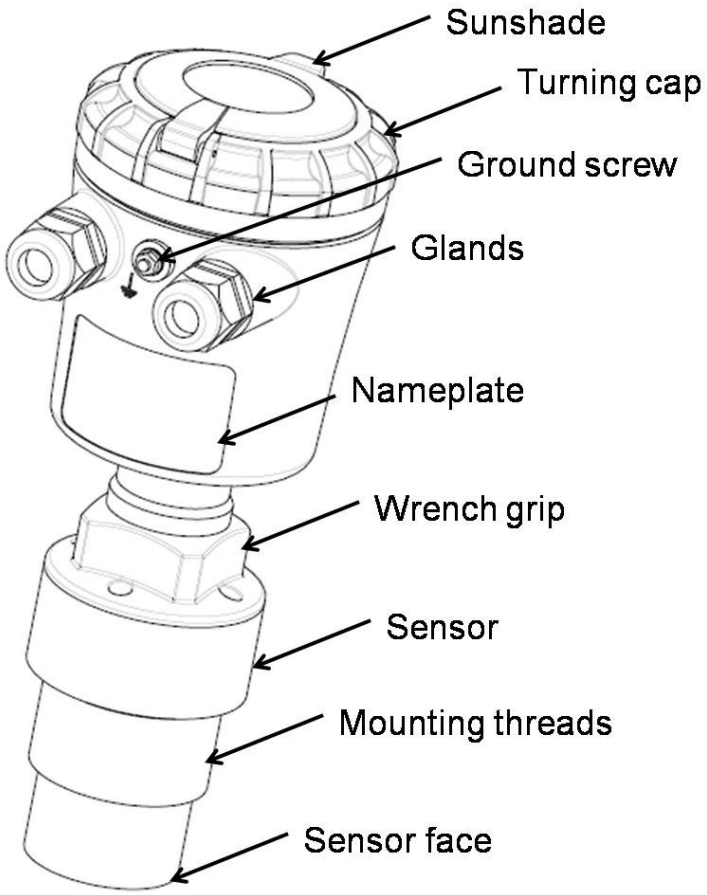


Figure 1 – Gauger420 parts

3. Dimensions

All figures in mm.

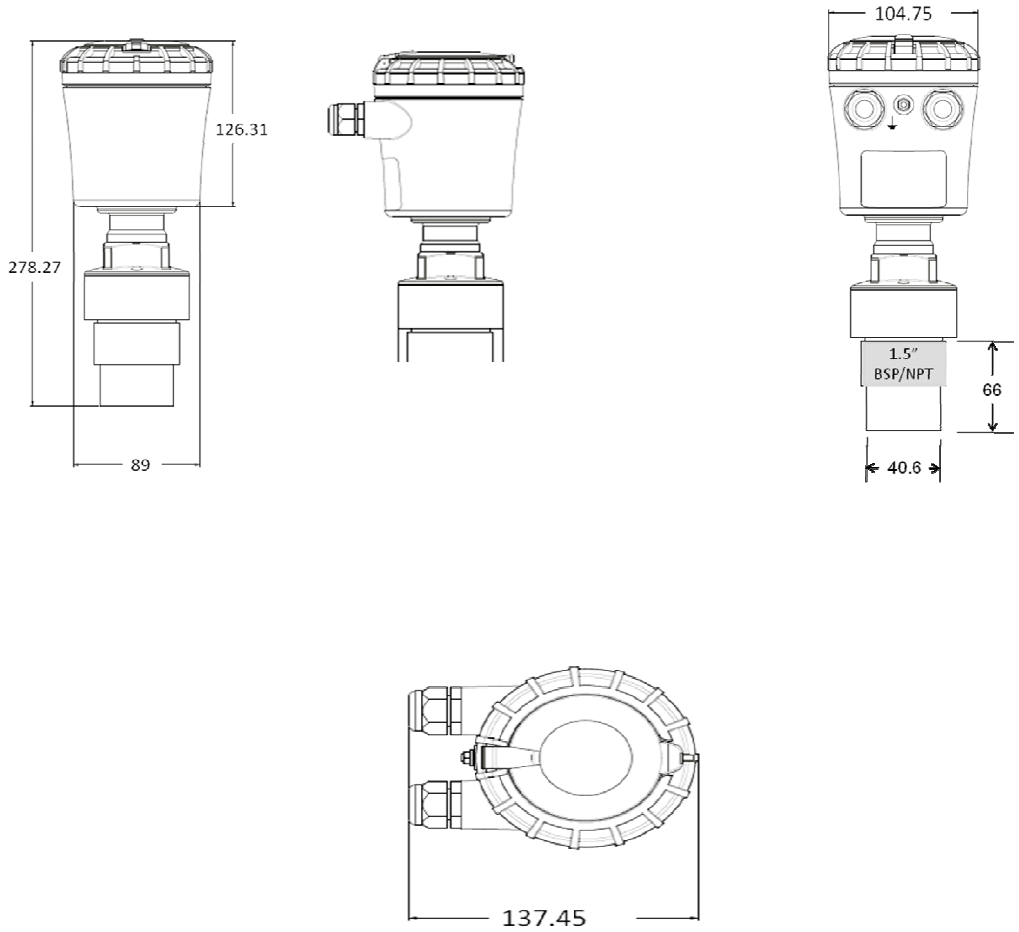


Figure 2 – Gauger*420* dimensions for 75 KHz version

4. Specifications

Measuring range (75 KHz version)

Maximum range for liquids	-	8 meter / 26’
Maximum range for Solids	-	5 meter / 16’ Approximate, depending on type of solid
Minimum range (dead zone)	-	15 cm / 6”

Measuring range (50 KHz version)

Maximum range for liquids	-	9.5 meter / 30’
Maximum range for Solids	-	6 meter / 19’ Approximate, depending on type of solid
Minimum range (dead zone)	-	35 cm / 10”

Accuracy – precision – resolution –tracking (75 KHz version)

Display Accuracy		
15cm<Range<60cm	-	1.5mm
60cm<Range<5m	-	0.3% of measured range
5m<Range<8m	-	0.2% of maximum range
Display Precision (repeatability)	-	0.2% of measured range
Display resolution	-	1 mm
Process tracking rate	-	10 meter per minute maximum
4-20 Accuracy	-	+/- 20µA For process rates up to 5 meter per minute

Accuracy – precision – resolution –tracking (50 KHz version)

Display Accuracy		
25cm<Range<60cm	-	1.5mm
60cm<Range<5m	-	0.3% of measured range
5m<Range<9.5m	-	0.25% of maximum range
Display Precision (repeatability)	-	0.3% of measured range
Display resolution	-	1 mm
Process tracking rate	-	10 meter per minute maximum
4-20 Accuracy	-	+/- 20µA For process rates up to 5 meter per minute

Electrical specifications

Power supply	-	24VDC or minimum 18VDC on Gauger Terminals

Current consumption	-	4.0mA – 20mA 3.6mA – 22mA for error settings
Loop current circuit	-	950Ω at 33VDC
USB port	-	For configuration and firmware upgrade
Display	-	64X128 Graphic LCD, viewing size 50X25mm^2
Reports		
Displayed	-	Level and percentage level Distance and percentage distance Volume Temperature (internal and external) Echo strength Global operating hours Resettable operating hours Ultrasonic status reports
4-20 representation	-	Level Distance Volume Fixed current 4mA and 20mA may be set independently
4-20 error indications	-	Target closer than Full level Target further than Empty level
4-20 error indications options	-	3.6mA or 22mA or Hold Last Value
HART options	-	Enabled or disabled Device address Four measurement variables
System Configuration options	-	Via local keypad and display By PC via USB port
Temperature characteristics		
Operational temperature range	-	-20°C to +70°C -30°C to +70°C for Gauger420 without display Note: above +60°C accuracy depreciates
Temperature sensors	-	Internal and optional support for external
Temperature compensation	-	Built-in based on internal sensor, external sensor or average of the two

Temperature display	-	Internal and external temperature Instantaneous and recorded high/low
Mechanical specifications		
Enclosure material	-	Plastic PC/ABS+UV
Sensor material	-	PVDF
Sealing rating	-	IP65/IP67
	-	IP68 - 96 hours at 1.8 meter depth in water
Mounting threads	-	1.5” BSP or 1.5” NPT (for 75 KHz version) 2.0” BSP or 2.0” NPT (for 50 KHz version)
Cable entries	-	Conduit ½”NPT
Weight	-	960 gram
Certifications	-	CE: EMC and Safety FCC Part 15

5. HOW TO USE THIS USER MANUAL

At this stage…	Do this…
First thing	Read the description section in this introduction chapter. Also review the safety guidelines right at the beginning of this user manual.
If you are not familiar with Level measurement terms	Review the section: Application dimensions and constraints in the reference guide chapter.
If you are ready to power up the Gauger	Review the sections: electrical schematics and electrical connections in the physical and electrical installation chapter.
If you want to quickly configure the Gauger	Study the chapter: keypad and display. Then read the section about quick setup in the chapter that follows.
If you want to know all about Gauger configurations	Study the chapter: configuration with a PC while referring to the reference guide chapter as required.
If you are about to install in the field	Carefully study the chapter: Physical and electrical installation guidelines.
If you are unsure about any term or concept	Consult with the reference guide chapter.

II. Physical and electrical installation guidelines

This chapter is a list of guidelines for proper physical installation of **Gauger420** on tanks including electrical connections. The final section is a short and concise list of instructions – the "must-be pamphlet". Always ensure that **Gauger420** is installed in an area that meets the stated ratings of the product including temperature and technical specifications

1. Geometrical considerations

- Gauger systems are installed above the target (e.g. water, fuel) being measured and should not make contact with the target at any time. Typically, the systems are installed on top of a tank (filled with liquid) through a hole on the roof of the tank. In outdoor applications, **Gauger420** may be attached to a metal arm extending above the target. The arm may be attached to a nearby post.
- **Gauger420** should be located as far as possible from vertical tank walls and from other physical obstructions such as filling inlets. Keep a minimum gap of: 30 cm plus 10 cm for each meter of measurement range.

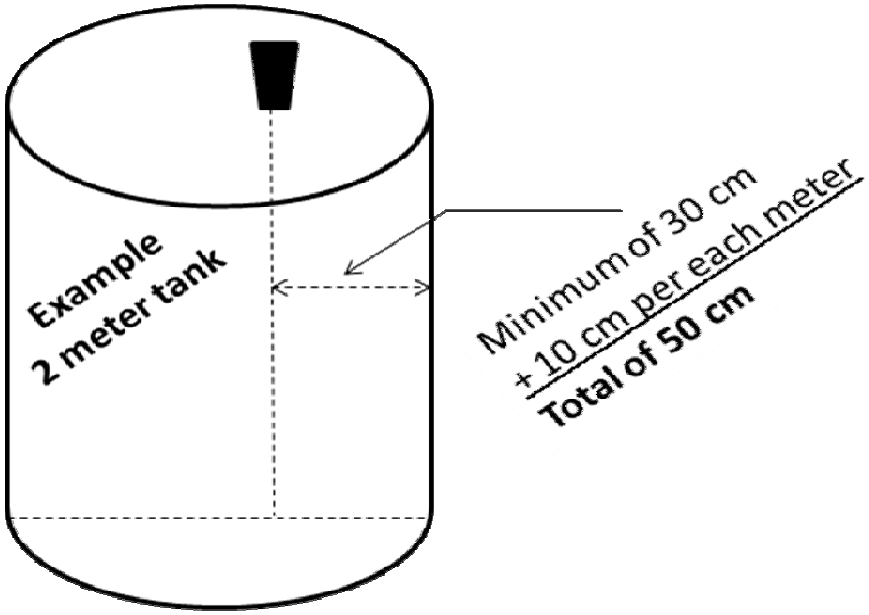


Figure 3 – Minimum horizontal gap

- For best results, place **Gauger420** away from sources of acoustic noise or sources of vibrations.

- **Gauger420** should be perpendicular to the surface of a liquid target. The angular displacement should be less than 5° from the vertical axis.

- For solids in silos, **Gauger420** should be aimed towards the center of the silo's base. The sensor should be displaced from the center of the tank and oriented perpendicular to the solids surface when tank is at full state.

Figure 4 - Silo (left) and liquid (right) examples

- Proper physical installation is accompanied by software setup. Setup includes defining parameters such as tank height and may include additional parameters such as NBD, FBD, False echo scan and more. For additional information read the section in the reference guide: "Application dimensions and constraints".

2. Tank fitting

Gauger420 is equipped with a 1.5"BSP / 1.5"NPT thread allowing two fitting options: direct fitting in a threaded flange or fastened with a 1.5" BSP / 1.5" NPT nut through a thread-free flange.

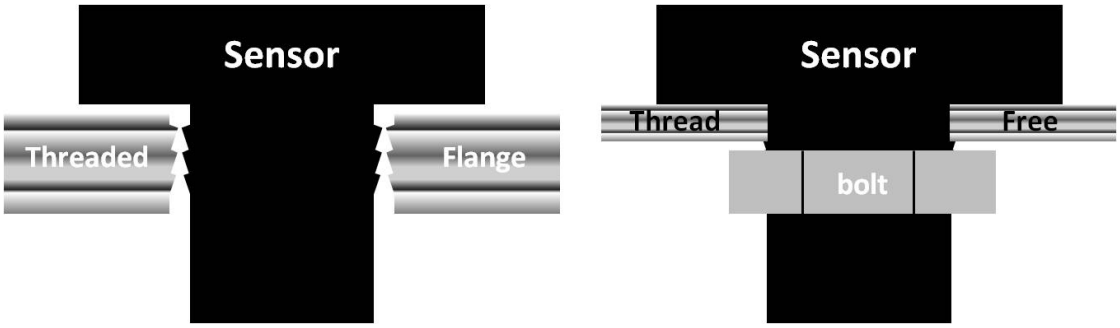


Figure 5 - Threaded flange (left) Thread-free flange (right)

For outdoor installations, use a stable arm. Firmly attach the sensor to the arm using a through-hole and threaded nut. Alternatively, attach the sensor to a threaded hole which is built-in the arm. Always verify thread compatibility between **Gauger420** and flange or nut. Do not use excessive force when using

threads. Preferably, tighten by hand only. If you do use a wrench, grip **Gauger*420*** at the wrench grip surfaces only (see figure **Gauger420** parts) and exert light force.

3. Dead zone

See reference guide: “Application dimensions and constraints”.

A gap must be kept between the face of sensor and the topmost level of the target. This gap must be at least the size of the specified “dead zone”. If the target level passes the dead zone, measurements may be unpredictable. Therefore, it is recommended to keep a margin gap between the expected topmost level and the dead zone border. Where the topmost level is too close to the tank roof, an extension pipe is required for the installation as described below.

4. Extension pipe

See reference guide: “Application dimensions and constraints”.

An extension pipe is required for installations where the topmost target level is too close to the roof of the tank. In such cases, an extension pipe is installed on the tank and the sensor is installed on top of the extension pipe at a safe distance from the topmost level of the target. The lower border of the dead zone may fall inside the tank as seen in the right hand side of the figure below. In this case no further software settings are required. The lower border of the dead zone may also fall within the extension pipe as described in the left hand side of the figure blow. In such cases, the Near Blocking Distance (NBD) should be configured in the software.

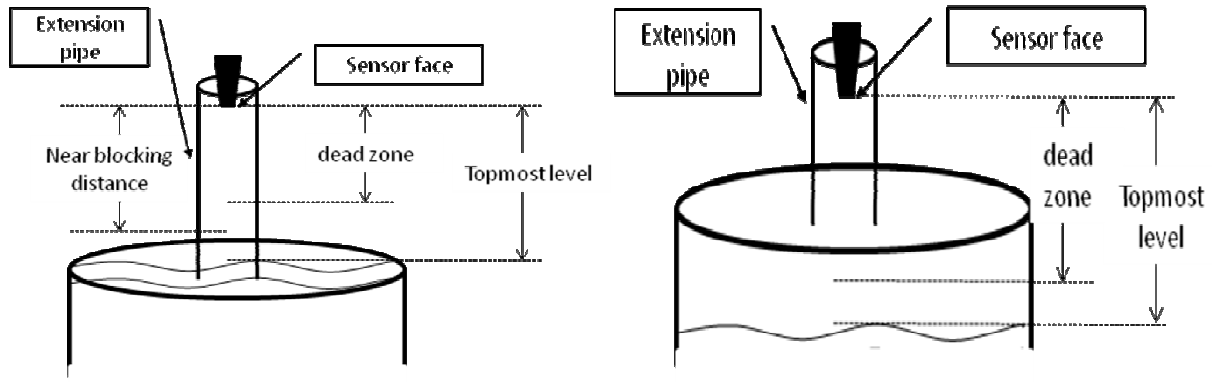


Figure 6 – Possible extension pipe settings

A typical structure of an extension pipe is shown on the next figure. Closely follow these guidelines when using an extension pipe:

- Internal pipe diameter should be at least 3” wide
- The diameter of the hole on the flange or tank should not be smaller than the pipe diameter
- Pipe length (measured from sensor face) should be no longer than 50 cm
- The pipe should not protrude into the tank

- Pipe should be exactly perpendicular to the surface of the target
- Sensor must be located at the center of the pipe
- Pipe should have a smooth interior surface
- The hole in the flange or tank should have a smooth edge and welding spots must be avoided
- Preferably, the pipe should be made of plastic

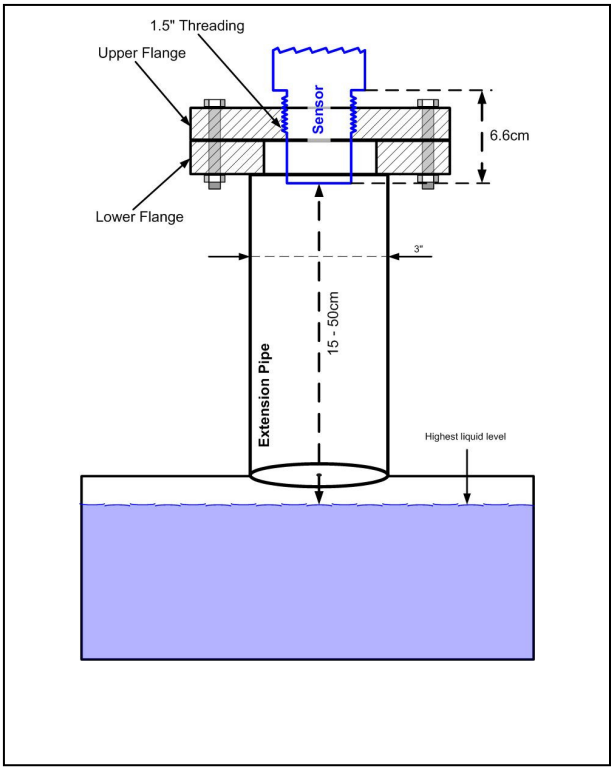


Figure 7 – Possible extension pipe fittings

5. Temperature considerations and temperature sensors

See also reference guide: "Temperature sensors, units and display".

When using an external temperature sensor, place the sensor at a location that best represents temperature of the air between the sensor face and the target. Avoid direct sunlight exposure and keep covered from rain. Connect the sensor internally as described in the electrical connection section to the Thermistor pins. External temperature sensors may be ordered from the manufacturer or reseller or may be purchased independently. Use Thermistor NTC 10K Ohm 5% (minimum) P/N 2381-640-63103 by Vishay BC Components or equivalent.

When using the internal temperature sensor, avoid situations where the **Gauger420** is exposed to different thermal conditions than its environment. Avoid direct sunlight on the Gauger. Direct sunlight

may overheat the system and cause measurement inaccuracies, measurement variations in time and even failure of the system in extreme cases.

If Gauger420 is exposed to direct sunlight, construct a local sunshade ("umbrella") over the Gauger.

In areas of large temperature variations, take into consideration volume changes of the target due to temperature expansion. Temperature coefficient of expansion may be as high as 1000ppm/1^{o}C.

6. Electrical schematics and power supply

Gauger*420* may be connected to the power supply in either a negative ground scheme or a positive ground scheme. These are presented in the following figures.

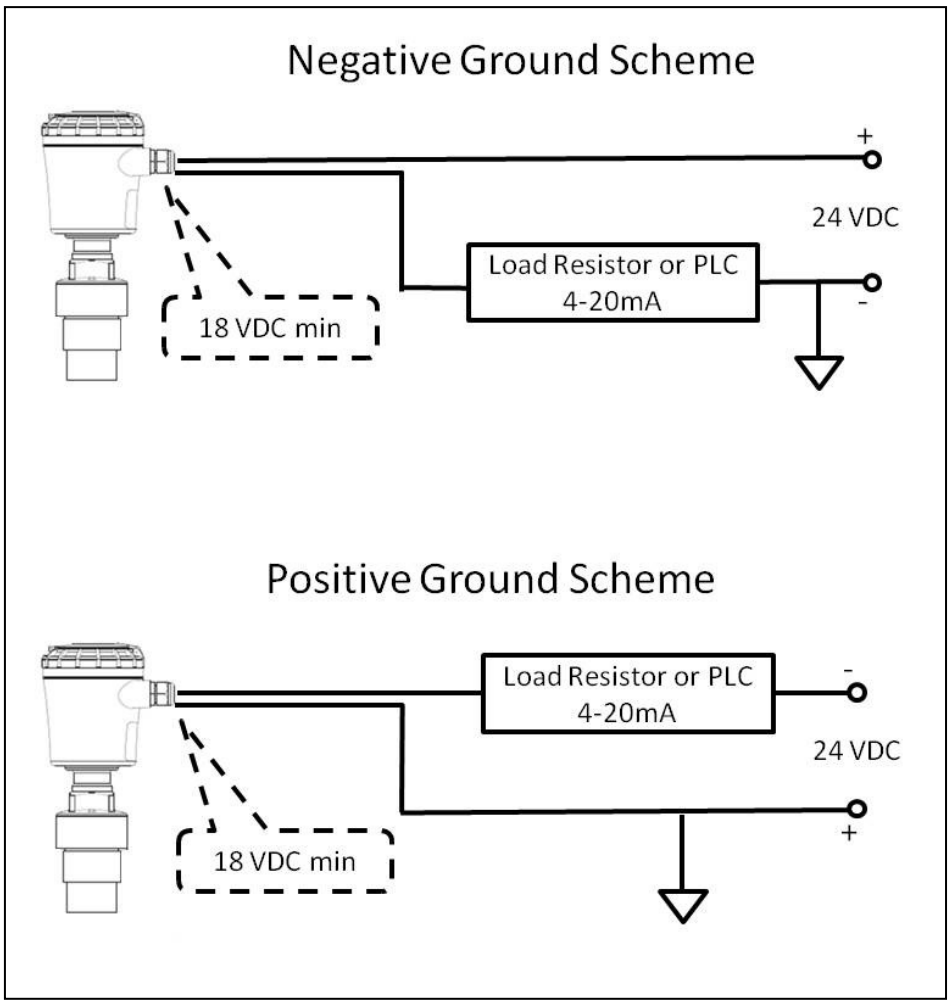


Figure 8 - Power supply and ground schemes

Under no circumstances should the voltage on Gauger420 terminals be less than 18VDC. Voltage drop calculation on any loop resistor should assume current of 25mA.

Recommendations for power supply characteristics:

- Ripple < 100 mV p-p
- Regulated switching power supply is recommended
- Rectified power supply should be avoided
- When powered by battery, avoid using a switched charger

Recommendations for the use of a PLC

- Always check that the voltage level on the terminals is at least 18VDC at a current of 25mA
- Check PLC specifications for the appropriate ground scheme options

When Gauger420 is connected to a 4-20 loop, do not connect any other device to the Gauger as this may damage loop devices such as PLCs or loggers. When configuring Gauger with a PC through the USB port, detach it from the 4-20 loop.

7. Electrical connections

7.1 Turn off **Gauger***420*.

7.2 Turn the **Gauger***420* top cap anti-clockwise and expose the electrical connections board. Review the connections as described in the following figure.

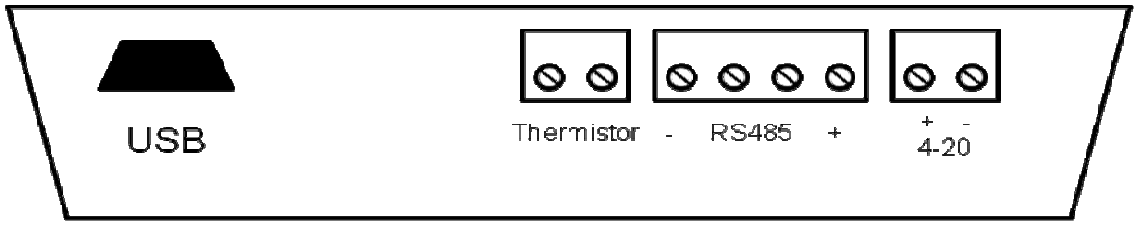


Figure 9 - Electrical ports

7.3 Insert cables (power and data as applicable) into the **Gauger***420* through one of the glands.

- Ensure that high voltage sources or cables are at least 1 meter away from **Gauger***420* and cables.
- Keep the electrical supply lines away from electromagnetic interference sources.
- When inserting a cable through the gland, use round cables with minimum diameter of 6 mm to ensure that the unit remains sealed to IP67.
- Connector ports may be pulled out for easy wire connection and then re-inserted back again.

Note: Unused cable conduit must be plugged with a gland using a dummy cable stub to keep IP rating.

7.4 Connect the power cables to the appropriate ports.

- Note that **Gauger***420* requires at least 24 VDC voltage on its ports.
- Always make sure that sufficient voltage is present on the **Gauger***420* power terminals, irrespective of any voltage drop along the supply lines

7.5 When using an external temperature sensor, connect the thermistor to the dedicated thermistor pins. This section applies to **Gauger***420* models that support an external temperature sensor.

7.6 The mini-USB port is a USB device-side supporting virtual COM ports. The port may be used for firmware upgrades and remote setup. Details about firmware upgrade are provided in the chapter: Firmware upgrade. Contact the manufacturer or reseller for compatible PC applications. Do not use the USB port when the Gauger is part of a 4-20 loop.

8. MUST BE Pamphlet

Consider copying and taking this page to the field with you.

1) Choosing location		
Distance to tank walls	**MUST BE**	at least 30cm from walls + 10cm/1m range
Flange	**MUST BE**	fixed on a horizontal surface
Acoustic noises	**MUST BE**	far away from acoustic noises and vibrations
Electrical interference	**MUST BE**	shielded away from power and sensor cables
Tank installation	**MUST BE**	far away from tank inlets, outlets, physical obstacles
Sensor	**MUST BE**	exactly perpendicular to the surface of the target
External thermistor	**MUST BE**	in shaded location, attached to the tank body
2) Handling dead zone		
Extension pipes (1)	**MUST BE**	of at least 3" internal diameter and 15 cm above target (from sensor face)
Extension pipes (2)	**MUST BE**	with completely smooth interior surface
Extension pipes (3)	**MUST BE**	installed with a flange/not protruding into the tank
3) Power source		
Voltage	**MUST BE**	at least 18VDC on unit terminals
Power source	**MUST BE**	rated higher than 18VDC due to voltage drop
Ripple and noise	**MUST BE**	not exceeding 100mV
Type	**MUST BE**	preferably regulated switching power supply
5) Measurement Configuration		
Full/Empty, Level/Distance	**MUST BE**	configured correctly
Filling rate	**MUST BE**	defined (consider the application)
Near blocking distance (NBD)	**MUST BE**	set up in flange and extension pipe installations

III. Keypad and display

This chapter describes the keypad and display of **Gauger***420*. The keypad and display add functionality to **Gauger***420:*

- Viewing measurement results and viewing information related to the system
- Configuring **Gauger***420*

Some models of **Gauger***420* are provided without a display/keypad. In these models configuration of the system is preformed with a PC. This chapter focuses on the structure and operation of the keypad and display. Configuration of the system is described in following chapters.

1. Keypad

1.1 Navigation keys

Use the navigation keys to scroll through the display.

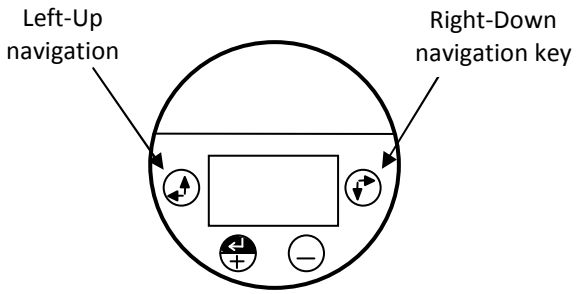


Figure 10 - Navigation keys

1.2 Execution keys

Use the execution keys to change a digit or to execute a command (Back, Next or Sub-menu):

- To change a digit: navigate to the digit and press the Plus (+) key or the Minus (-) key.
- To execute a command: navigate to the command and press the Enter (+) key.

Remember – some changes are saved only after returning to the measurement screen. If you shut down **Gauger***420* before you return to the measurement screen, your changes may be lost.

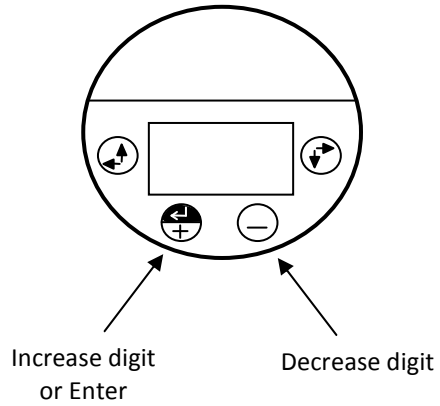


Figure 11 - Execution keys

2. Navigation through menus

Gauger*420* supports two menu styles which are used throughout the setup operations and are described below. False echo scan employs another menu style and is described at the relevant section.

2.1 Sub-Menu style

The Sub-Menu style presents a list of vertical choices. An arrow may appear on the right hand side of the screen if additional items can be reached when scrolling down. The scrolling is cyclic, meaning that when you reach the last (first) item, the next step will lead you to the first (last) item. Scroll up or down, using the navigation keys, to your selected choice and press Enter (+). This action will lead you to the next Sub-Menu.

The last item in the list of choices is **back**. Select ****back**** to return to the previous menu. The previous menu will be displayed such that your last selection will appear first on the menu.

For example:

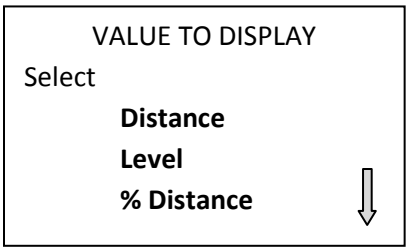


Figure 12 - Sub menu screens

2.2 Numeric menu style

The Numeric menu style presents you with a multi-digit number which may be modified. Navigate to each digit and modify the digit as required by using the Plus (+) or Minus (-) keys.

When you are done with all digits, select Next to store the modified parameter. Select Back to ignore the changes and return to the previous sub-menu. Modifications will become permanent (survive a reset) when you navigate back to the measurement screen.

For example:

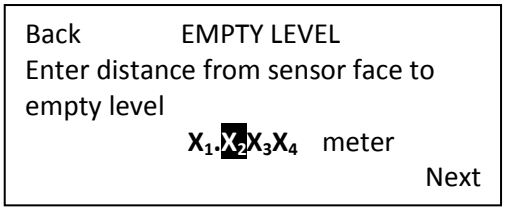


Figure 13 - Numeric menu

By repeatedly pressing the Right-Down navigation key, you will follow this route:

$X_1 \rightarrow X_2 \rightarrow X_3 \rightarrow X_4 \rightarrow$ Next $\rightarrow$ Back $\rightarrow X_1 \rightarrow X_2 \rightarrow \ldots$

Conversely, by repeatedly pressing the Left-Up navigation key, you will follow the opposite route.

After pressing Next, Gauger will check the validity of your numerical entry. If your entry is outside the acceptable boundaries, an ILLEGAL VALUE screen will be presented. You need to press any key to return to the previous screen. A default value will replace your wrong entry. If so needed, modify the numerical entry and press Next again.

3. Measurement screen

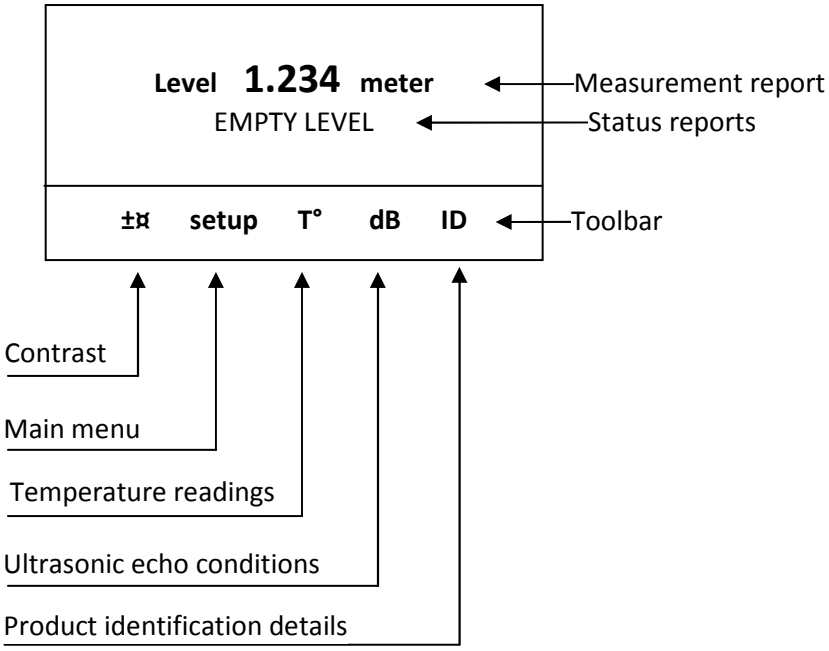


Figure 14 - Measurement screen

The top line presents the current measurement information.

3.1 Status reports

Status reports appear beneath the measurement result. Reports related to ultrasonic metering issues are presented. Ultrasonic reports include messages such as: FULL LEVEL, EMPTY LEVEL, ECHO SEARCH and others.

The bottom line on the screen presents a toolbar with choices. Navigate through the toolbar and select an action or report. **Gauger***420* halts any operations (including measurements) during navigation. **Gauger***420* will automatically resume operations 30 seconds after last key has been pressed.

3.2 Contrast

Press the Plus (+) or Minus (-) keys to change visual contrast of the display.

3.3 Main menu / setup

Navigate to Setup and press Enter (+) to configure **Gauger***420*. The actual configuration process is explained in a following chapter.

3.4 Temperature readings

Navigate to the T° symbol on the toolbar and press Enter (+). The following table will be displayed:

Sens:	Cur	High	Low
Int	29.5	31.0	26
Ext	29.4	32	23.3

Reset Done

Figure 15 - Temperature readings

The table is explained in the reference guide section: "Temperature sensors, units and display". Press Reset to reset recorded high / low temperatures or press Done to return to the measurement screen.

3.5 Ultrasonic echo conditions

Navigate to the dB symbol and press Enter (+). You will be presented with the measured echo amplitude and the maximum amplitude available. The amplitudes are presented in dB relative to a system threshold amplitude. Echo amplitude should be above threshold amplitude for reliable measurement. Echo strength between 3dB and 8db (maximum) is reliable. Echo amplitude refers to the echo measured just prior to navigating through the toolbar. Press Done to return to the measurement screen.

3.6 Product identification details

From the measurement screen, navigate to the ID symbol on the toolbar and press Enter (+). Product information will be displayed: Serial Number and Part Number. Press Back to return to the measurement screen or navigate to one of the options: Software information (SW), Hardware information (HW) or Manufacturing Date information (Date). SW screen will display firmware versions of the embedded application and of the embedded Boot-Loader. Press Back to return to the previous menu. HW screen will display product information regarding sensor type and model type. Press Back to return to the previous menu. Date screen will present the date of manufacturing. Press Back to return to the previous menu.

IV. Configuration with the keypad and display

1. Menu and sub-menu organization

Gauger420 menus and submenus are organized in a tree-like format. The organization is described in the following figure.

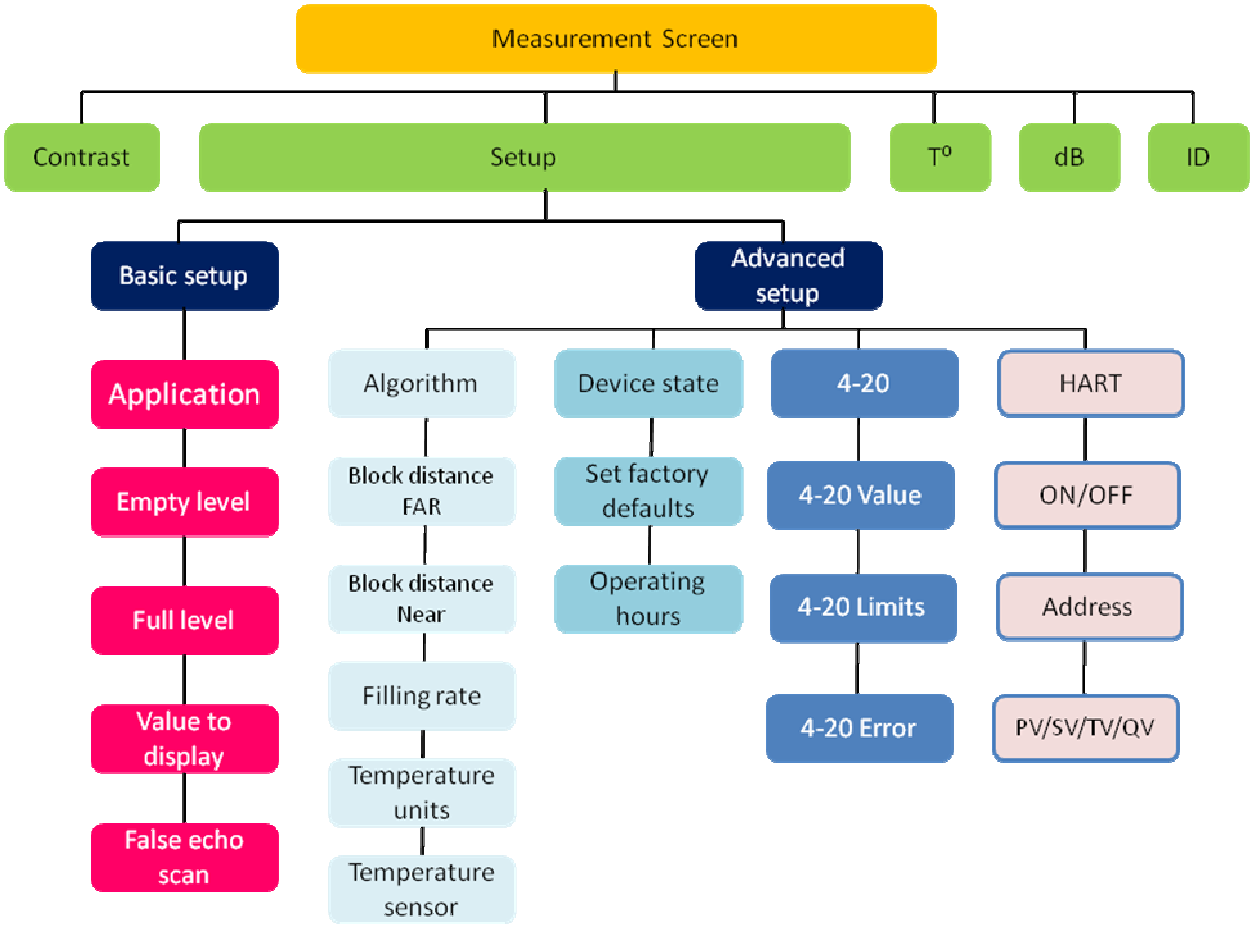


Figure 16 - Menu and submenu organization

2. Quick Setup

Set **Gauger***420* for operation by a quick 7-step wizard-driven procedure using the basic menu option.

Note: Configuration using the display and keypad supports metric units only. For American units, use the PC configuration method as described in the chapter describing configuration with a PC.

a. Turn on **Gauger***420* and wait for the measurement screen to show up. Navigate through the toolbar and select setup.

b. Scroll and select Basic Setup from the Main Menu.

c. Scroll and select application (Low power or High power). For additional details about the application type refer to the reference guide chapter under: “Application type”.

d. Determine distance to empty level. For additional details about the empty level see the reference guide section: “application dimensions and constraints”. When you are done press Done.

e. Determine distance to the full level. For additional details about the full level see the reference guide section: “application dimensions and constraints”. When you are done press Done.

f. Scroll and select value to display. For additional details about value-to-display see the reference guide section: “Distance units and value to display”.

g. Skip or perform false echo search. See the section “False echo scan” in the reference guide chapter.

Perform a false echo scan when obstructions are nearby the target or sensor. Preferably, false echo scan should be performed when the tank is empty. If you choose to perform false echo scan, wait for about a minute and then you will be presented with a list of echoes.

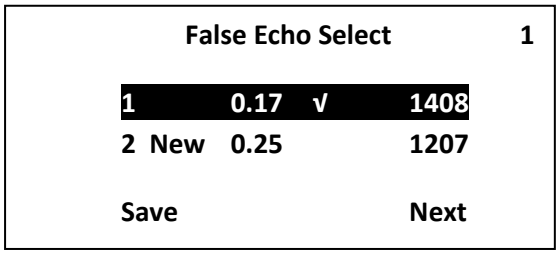


Figure 17 - False echo scan screen

Scroll through the listed echoes and press Enter (+) on each echo you would like to ignore during measurement. Each such echo will be designated by a √ sign. The number of selected echoes is

presented on the top-right edge of the screen. Press Save to store your selection and Next to proceed to the next sub-menu. To un-select an echo, scroll to that echo and press Enter (+) again. If you choose to perform false echo scan a second time, new echoes which were not identified during the first scan will be reported as "new".

The Gauger is now ready for measurements.

Parameters not determined during quick setup procedure will take their default value and may be modified later using the Advanced Setup menu.

> Note: Always verify then re-verify that your basic settings are correct including distance to empty level, distance to full level, level or distance choice. Most wrong readings originate from incorrect setup.

3. Advanced settings

Gauger420 supports a set of advanced settings. These settings are classified under four different categories: 4-20, HART, Algorithm and Device state. The following items may be modified under each category:

Category	Sub menu items	See section in reference guide…	Notes
4-20			
	Variable represented	"4-20 communications"	
	Value represented	"4-20 communications"	4mA 20mA
	Error signal	"4-20 communications"	3.6mA 22mA Hold
HART	On / Off	"HART communications"	
	HART address	"HART communications"	
	PV, SV, TV, QV presentation	"HART communications"	
Algorithm			
	Far blocking distance	"Application dimensions & constraints"	
	Near blocking distance	"Application dimensions & constraints"	
	Filling rate	"Filling rate"	
	Temperature units	"Temperature sensors, units and display"	
Device state			
	Reset to defaults	"Reset and operating hours"	
	Operating hours	"Reset and operating hours"	

To execute any of the advanced settings, follow these steps: Turn ON **Gauger420** and wait for the Measurement screen to show up. Navigate and select Setup. Then scroll and select Advanced Setup from the Main Menu. Now select the required category (GSM, Algorithm or Device state) and follow the screen instructions. When done, scroll and press **back** to return to the Main Menu an then scroll and select the measurement display.

Each item may either present a selection of sub-items to choose from or may require entry of a numeric field.

> If you are not sure what sub-item to select or how the numeric field should be modified, than leave the default values as is.

4. Settings available in PC configuration only

Some advanced settings are available in a PC configuration only and cannot be configured with the display/keypad. These settings are defined in the following table.

Setting	Options	PC Command
Units	Meter, feet, Liter, Gallon	UNT
Value to display	Volume	VAL
Tank shape and dimensions	Cubic, Cylindrical	CUB, CYLV, CYLH

V. Configuration with a PC

1. Introduction

Gauger420 is pre-configured at the factory to default settings. See reference guide section: "Default Values". The system is delivered to the user ready for operation. Some configuration parameters should be re-configured by the user for proper field application. **Gauger420** can be configured by a simple PC tool.

Configuration by PC may be used in lieu of configuring with the integral keypad and display. PC configuration provides the user with the full set of configuration items. Furthermore, configuration by PC allows the user to clone fielded Gauger420 systems. For this cloning process, the user is required to prepare one text file and download that file into all relevant **Gauger420** systems. Once this configuration file is prepared, the downloading process takes a few seconds and makes redundant any manual keypad based operation.

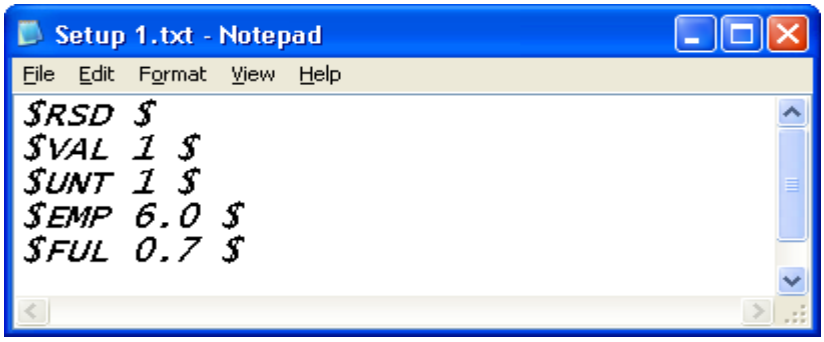
Section 2 below begins by demonstrating a sample configuration text file.

Section 3 handles the downloading operation. The download process involves use of a standard Windows application – HyperTerminal. The setup of HyperTerminal is explained in the second section and parts of it may be skipped by those who are already familiar with this tool. Section 4 presents possible responses from **Gauger420** –whether good or erroneous responses. Section 5 is a list of all configuration items. Section 6 provides some configuration file example.

2. Preparing a configuration text file

2.1 Sample files

The following text file was created using Windows Notepad application and demonstrates the essence of the configuration file:



Digest line by line:

- Reset **Gauger420** to its default values.
- Value to Display is LEVEL
- Unit system is Metric

- EMPTY LEVEL is set to a distance of 6.0 meters
- FULL LEVEL is set to a distance of 0.70 meters

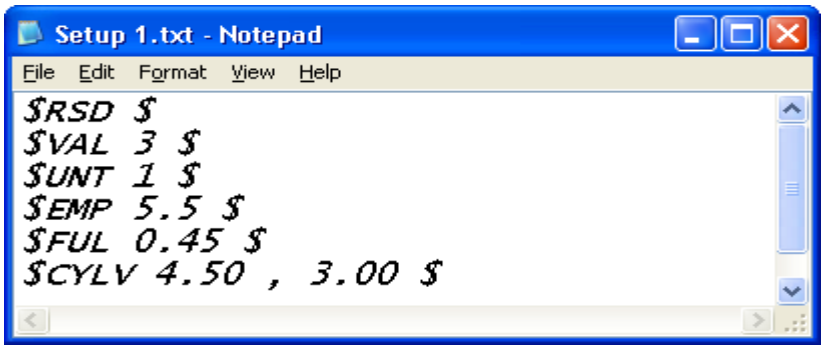
If you are unfamiliar with terms such as empty level or full level read reference guide section: "Application dimensions and constraints". Next is a slightly more complex configuration file:

Summary notes:

- Each line begins, and ends, with a **$ sign**.
- All commands are made of Capital letters.
- Each command is immediately adjacent to the first $ sign.
- There is a blank between the command and the related parameter.
- It is highly recommended to begin each configuration file with **RSD** then **VAL** then **UNT**. Other combinations, while not illegal, may result in setup misinterpretation.

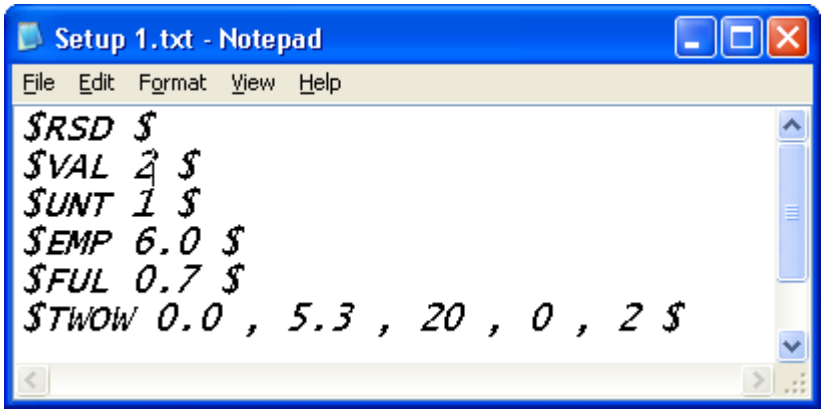
2.2 Multi Value commands

Some configuration items are assembled from two values or more. For example, the dimensions of a vertical cylindrical tank (prefix CYLV) are height **and** diameter. These two values are both included with a **comma in between** the two values. The next figure illustrates the use of the comma.



The second line instructs **Gauger*420*** to display VOLUME results (rather then LEVEL or DISTANCE). The third line instructs **Gauger*420*** to display volume in liters. The last line instructs **Gauger420** to set the tank as a **vertical cylindrical tank** with **height** of 4.5 meter and **diameter** of 3.00 meters. C**omma should always separate** between values on the same line.

The final example demonstrates the configuration of 4-20.



The last line instructs **Gauger***420* to set the 4-20 as follows (interpreted from left to right):

- 4mA represents Level of 0.0 meters
- 20mA represents Level of 5.3 meters
- NA
- 4-20 represents LEVEL
- Error state is HOLD LAST VALUE

3. Download operation

3.1 Procedure

Gauger420 can be configured by downloading the text configuration file from your PC into **Gauger420**. The previous chapter described the making of the configuration file. This chapter describes the **download procedure.** The download process can be preformed using **HyperTerminal** – a Microsoft standard application which is part of Windows XP and earlier operating systems. Similar applications may also be used. HyperTerminal application can also be copied to Windows 7.

Prior to using the HyperTerminal, you must connect **Gauger420** to the PC and install a USB-Serial driver on the PC. You can do that by following the instructions in the chapter: “USB driver installation on a PC”.

You should find out the COM port number that **Gauger420** is using on the PC. **Gauger420** must be in the measurement screen during download procedure. Two PC applications trying to access **Gauger420** will conflict with each other. Avoid having two such applications running at the same time.

3.2 Launching and setting up HyperTerminal

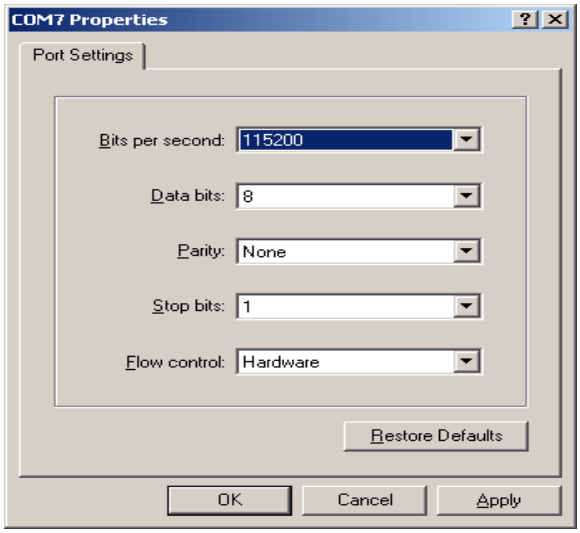
This section assumes you are using Windows XP. Similar procedures apply to other operating systems.

3.2.1 Go to Start Menu and then Open Programs.
3.2.2 Open Accessories, then Open Communications then Open HyperTerminal.
3.2.3 Press NO when asked about “default telnet program”

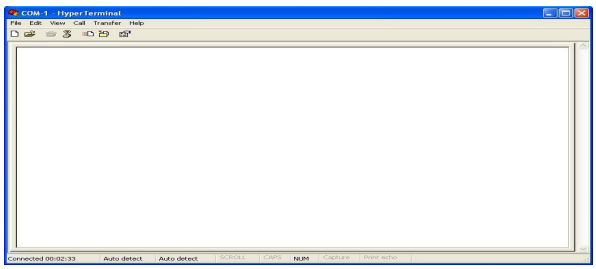
3.2.4 When prompt for a name, choose any name and press OK.

3.2.5 In the next window “Connect to”, select the COM port that you intend to use for Gauger420. This part is described in the next figure:

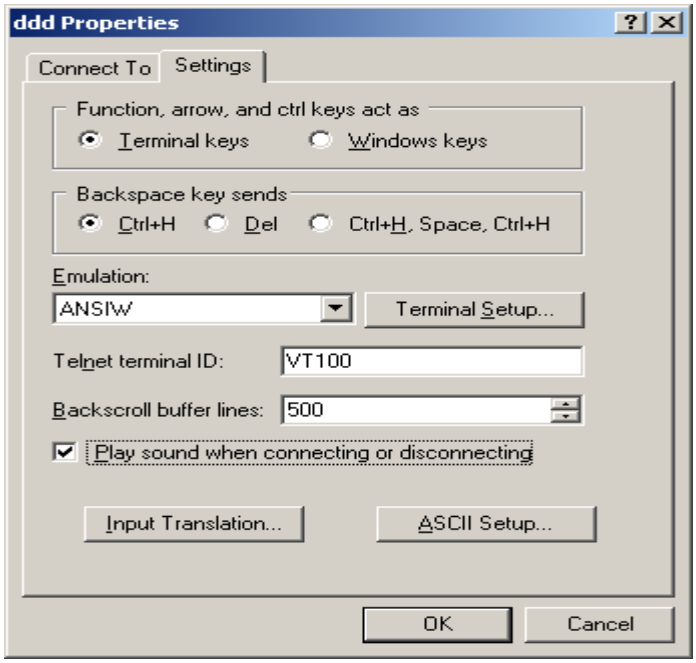
3.2.6 In the next window “COM properties - port settings” set the parameters as described below:



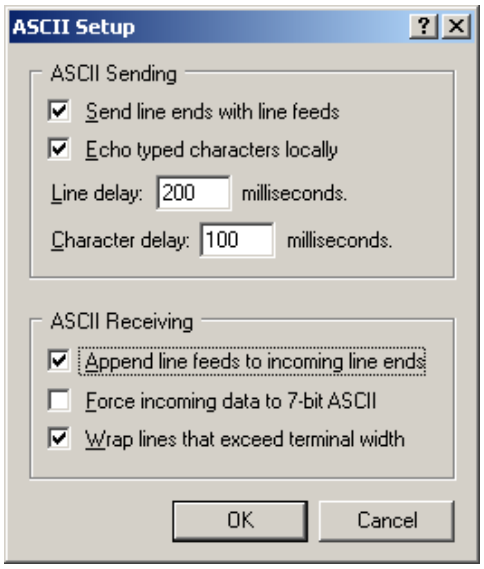
3.2.7 Now you should see the HyperTerminal screen:



3.2.8 Select the File tab (on the top left side) and choose properties then settings and set the parameters as described below:



3.2.9 Now press on ASCII setup (bottom right side) and set the parameters as described below:



Especially note the "Line Delay" and the "Character delay" which **are not** the default values of HyperTerminal.

Note: When using the USB port for local serial data monitoring (see appropriate chapter), you should return to the default values of the screen above and specifically uncheck "Append line feeds to incoming line ends". And vice verse, if you revert to configuration of Gauger420 through the USB interface, make sure to set the parameters of the screen above correctly.

3.2.10 Press OK and then OK again – **you are all set to configure Gauger420**.

3.3 Downloading a configuration file

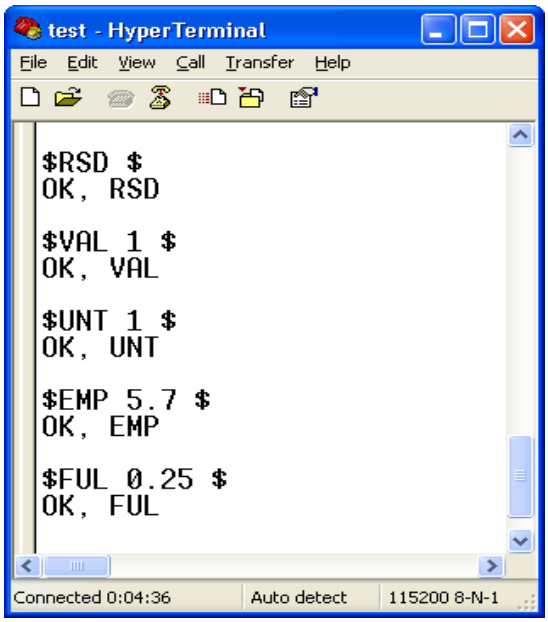
3.3.1 From the HyperTerminal screen select transfer (top right side tab) and then select “Send Test File”.

3.3.2 Browse to the directory where you stored the configuration text file (the one you prepared in the previous section) and select that file. Double click on the file to transmit it.

3.3.3 Alternatively, you can key each configuration item line by line directly from the HyperTerminal screen. As a quick test of this configuration, key the following command:
$VAL 1 $
Watch **Gauger420** integral display and verify that measured data is Level.
Now key the following command:
$VAL 2 $
Watch **Gauger420** integral display and verify that measured data is Distance.

4. Responses from Gauger420

4.1 Good response
GaugerGSM should reply with an **OK response** to each command accompanied by the command name. The next example shows five legal commands.



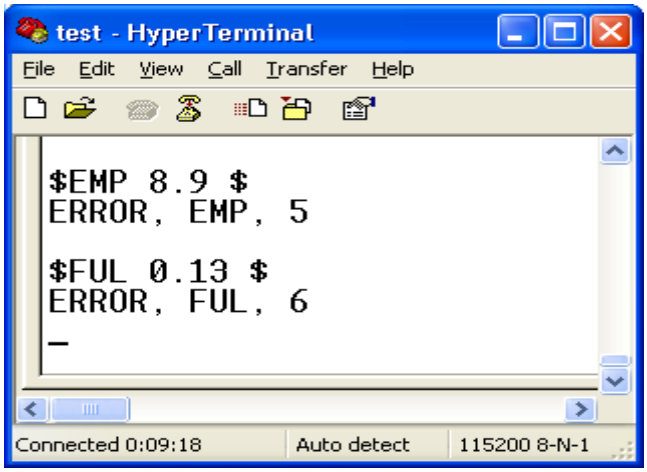
4.2 Erroneous responses

GaugerGSM will reply with an **ERROR** response to a wrong configuration item.

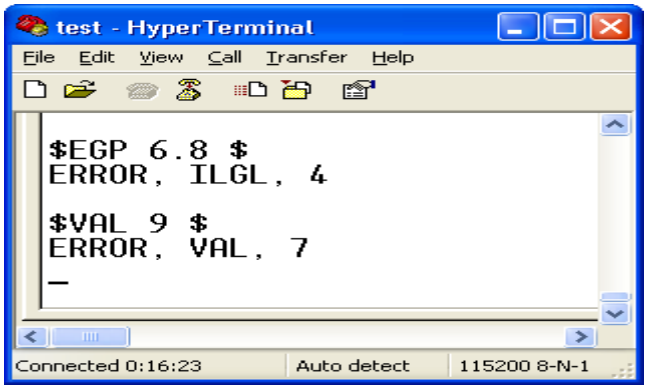
In the next example:

EMP = 8.9 meters is illegal for GaugerGSM-75 (maximum is 8 meters) and will produce ERROR #5: Value exceeds upper limit.

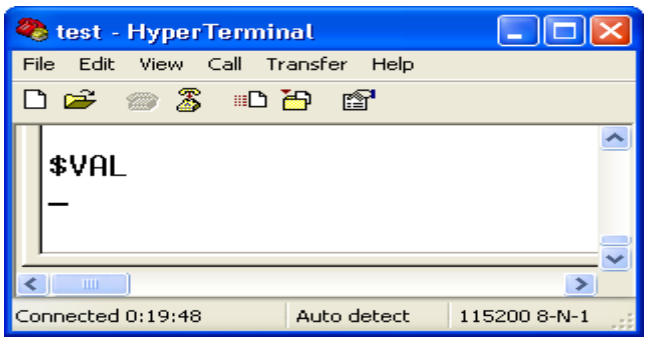
FUL = 0.13 meters is illegal for GaugerGSM (minimum is 0.15 meters) and will produce ERROR #6: Value is below lower limit.



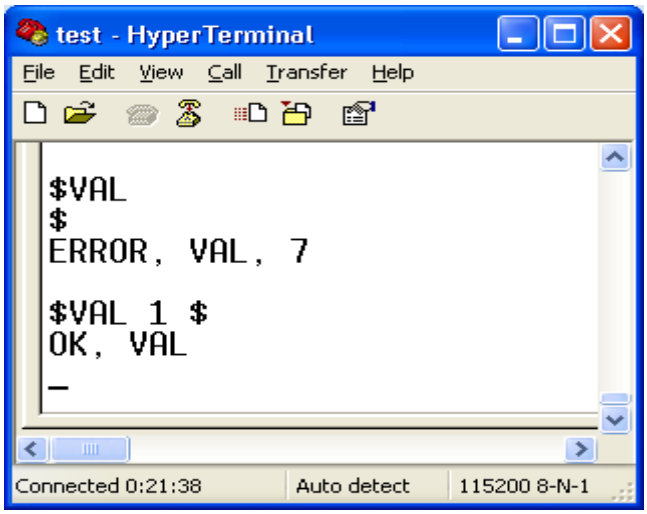
Additional errors may occur if command is wrong. In the next example, the non-existent command EGP results in ERROR#4 and a non existent value (VAL=9) results in ERROR#7.



Finally, misalignment of $ signs may occur as follows:



In the example above, the closing $ was not typed and the system is waiting for this $ sign. In these cases, type $ and re-enter the complete command as follows:



Some of the common error numbers are listed below:

Error code	Most probable cause
4	Wrong command name or command not adjacent to $ sign
5	Value is exceeds upper legal limit
6	Value is below lower legal limit
7	Value is illegal

4.3 Communication Errors

The erroneous responses described indicate that the link between PC and Gauger420 is operating fine and that the commands are of wrong nature. If no responses are received from Gauger420 or if the responses carry unfamiliar characters, the communication link between the PC and Gauger420 is not performing. In this case, you need to check the physical cabling, verify the HyperTerminal settings and then restart this application again.

5. List of commands for configuration from a PC

5.1 Conventions

The following conventions apply for the list of commands. These conventions refer to the values allowed for each parameter.

5.1.1 Range of number values

A range of number values is presented with a hyphen. For example: **0.150-8.000**. This entry means that the value may be any number between 0.150 and 8.000. Always use the decimal point. The number of decimal digits may be less than three.

5.1.2 Range of whole number values

A range of whole number values is presented with a hyphen. For example: **1-99**. This entry means that the value may be any whole number between 1 and 99.

5.1.3 Several distinct values

When a parameter can be one of a few distinct values, each value is listed on separate lines with an explanation. For example:

Command	Command Description	Possible values	Value description
VAL ([3])	Value to display	1	Level
		2	Distance
		3	Volume (set also tank shape)

5.1.4 Two parameters for the same command

An entry such as **1-9999 , 0.150-8.000** means that the command is made of two parameters and requires two values. A comma separates the two values. In this example the first value may be any whole number between 1 and 9999. The second value may be any number between 0.150 and 8.000.

5.1.5 Two parameters with one parameter fixed

An entry such as **1-99 , 0** means that the configuration item requires two values but the second value must be 0. The first value in this example may be any whole number between 1 and 99.

The user may select one of two units systems: Metric or American. A separate command list is provided below for each unit system. The user can select his/her preferred unit system with the UNT command.

5.2 List for Metric unit system

Item	Description	Possible values	Value description
Basic setup (Metric)			
APP ([1])	Application type	0	High power
		1	Low power
EMP ([2])	Empty level	0.150 – 8.000	Distance in meters
FUL ([2])	Full level	0.150 – 8.000	Distance in meters
VAL ([3])	Value to display	1	Level
		2	Distance
		3	Volume (set also tank shape)
		4	% Level
		5	% Distance
		6	% Volume (set also tank shape)
		7	Flow (see also OCF command)
		8	%Flow
UNT ([3])	Units for VAL=1,2,4,5	1	Meter
		2	Feet (see list for American units)
UNT ([3])	Units for VAL=3,6	3	Liter
		4	US Gallons (see list for American units)
Advanced setup (Metric)			
FBD ([2])	Far blocking distance	0.150 – 8.000	Distance in meters
NBD ([2])	Near blocking distance	0.150 – 8.000	Distance in meters
RAT ([4])	Filling (tracking) rate	0	1 meter / minute
		1	2 meter / minute
		2	5 meter / minute
		3	10meter / minute
TMP ([5])	Temperature unit system	3	Celsius
		4	Fahrenheit
SNS ([5])	Temperature sensor	0	Internal sensor
		1	External sensor
		2	Average of both
Tank shapes and dimensions (Metric)			
CUB ([7])	Cubic tank	0.00-99.99 , 0.00-99.99	Width and depth (horizontal dimensions) in meter.
CYLV ([7])	Vertical cylindrical tank	0.00-99.99 , 0.00-99.99 , 0	Height of tank = EMP value in meter Diameter of tank in meter
CYLV ([7])	Vertical cylindrical tank with concave bottom	0.00-99.99 , 0.00-99.99 , 0.00-99.99	Height of tank = EMP value in meter Diameter of tank in meter Breadth of bottom in meter
CYLH ([7])	Horizontal cylindrical tank with curved sides	0.000-99.99 , 0.000-99.99 , 0.001-99.99	Length, diameter and curved breadth in meter.
CYLH ([7])	Horizontal cylindrical tank with flat sides	0.000-99.99 , 0.000-99.99 , 0	Length and diameter in meter.

4-20 and HART (Metric)			
TWOW ([9])	4-20mA configuration when representing: Level **([2])**	0.0 – 8.000, 0.0 – 8.000, 20.0, 0, 0-3	The low Level represented by 4mA. The high Level represented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when representing: Distance (reverse Level) **([2])**	0.15 – 8.000, 0.15 – 8.000, 20.0, 3, 0-3	The short Distance presented by 4mA. The long Distance presented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when representing: Volume**([2])** For VAL = 3, 6 only.	0 – min Volume, 0 – max Volume, 20.0, 2, 0-3	The small Volume presented by 4mA. The large Volume presented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when representing: Flow**([2])**	0 – min Flow, 0 – max Flow, 20.0, 1, 0-3	The small Volume presented by 4mA. The large Volume presented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when disabled: Fixed current	0, 0, 4.0 - 20.0, 4, 0-3	 The fixed current level. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA.

			2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
HART ([10])	HART configuration and enable **([5])**	0-6, 0-6,0-6, 0-6, 0-15, 1	PV, SV, TV, QV where: 0-Distance, 1-Level, 2-Volume, 3–Temperature, 4-%Distance, 6 - %Level, 6-%Volume, , 7-Flow, 8-%Flow HART device address HART device address
HART ([9])	HART Disable	0,0,0,0,0,0	

All notes are explained in section 5.5

5.3 List for American unit system

Item	Description	Possible values	Value description
Basic setup (American)			
APP ([1])	Application type	0	High power
		1	Low power
EMP ([2])	Empty level	0.50 – 26.00	Distance in feet
FUL ([2])	Full level	0.50 – 26.00	Distance in feet
VAL ([3])	Value to display	1	Level
		2	Distance
		3	Volume (set also tank shape)
		4	% Level
		5	% Distance
		6	% Volume (set also tank shape)
		6	% Volume (set also tank shape)
		7	Flow (see also OCF command)
UNT ([3])	Units for VAL=1,2,4,5	1	Meter (see list for metric units)
		2	Feet
UNT ([3])	Units for VAL=3,6	3	Liter (see list for metric units)
		4	Gallons (US)
Advanced setup (American)			
FBD ([2])	Far blocking distance	0.50 – 26.00	Distance in feet
NBD ([2])	Near blocking distance	0.50 – 26.00	Distance in feet
RAT ([4])	Filling (tracking) rate	0	3 feet / minute
		1	6 feet / minute
		2	15 feet / minute
		3	30 feet / minute
TMP ([5])	Temperature unit system	3	Celsius
		4	Fahrenheit
SNS ([5])	Temperature sensor	0	Internal sensor
		1	External sensor
		2	Average of both
Tank shapes and dimensions (American)			

CUB ([7])	Cubic tank	0.00-300.00 , 0.00-300.00	Width and depth (horizontal dimensions) in feet.
CYLV ([7])	Vertical cylindrical tank	0.00-300.00 , 0.00-300.00 , 0	Height of tank = EMP value in feet Diameter of tank in feet
CYLV ([7])	Vertical cylindrical tank with concave bottom	0.00-300.00 , 0.00-300.00 , 0.01-300.00	Height of tank = EMP value in feet Diameter of tank in feet Breadth of bottom in feet
CYLH ([7])	Horizontal cylindrical tank with curved sides	0.000-300.00 , 0.000-300.00 , 0.001-300.00	Length, diameter and curved breadth in feet**.**
CYLH ([7])	Horizontal cylindrical tank with flat sides	0.000-300.00 , 0.000-300.00 , 0	Length and diameter in feet.
4-20 and HART (American)			
TWOW ([9])	4-20mA configuration when representing: Level **([2])**	0.0 – 26.00, 0.0 – 26.00, 20.0, 0, 0-3	The low Level represented by 4mA. The high Level represented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when representing: Distance (reverse Level) **([2])**	0.50 – 26.00, 0.50 – 26.00, 20.0, 3, 0-3	The short Distance presented by 4mA. The long Distance presented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when representing: Flow**([2])**	0 – min Flow, 0 – max Flow, 20.0, 1, 0-3	The small Volume presented by 4mA. The large Volume presented by 20mA. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW ([9])	4-20mA configuration when representing:	0 – max Volume, 0 – max Volume,	The small Volume presented by 4mA. The large Volume presented by 20mA.

	Volume**(2)** For VAL = 3, 6 only.	20.0, 2, 0-3	 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
TWOW (9)	4-20mA configuration when disabled: Fixed current	0, 0, 4.0 - 20.0, 4, 0-3	 The fixed current level. 0 – Error state represented by 3.6mA. 1 – Error state represented by 22mA. 2 – Last value is held at error state. 3 – Error state is represented by 3.6mA or by 22mA whichever is nearer to last value.
HART (10)	HART configuration and enable **(5)**	0-6, 0-6,0-6, 0-6, 0-15, 1	PV, SV, TV, QV where: 0-Distance, 1-Level, 2-Volume, 3–Temperature, 4-%Distance, 6 - %Level, 6-%Volume, 7-Flow, 8-%Flow HART device address
HART (10)	HART Disable	0,0,0,0,0,0	

All notes are explained in section 5.5

5.4 List for unified commands

Item	Description	Possible values	Value description
Open Channel Flow (OCF)			
OCF	No OCF	0	To be used for disabling a previously defined OCF
OCF (17)	Rectangular suppressed sharp crested weir	1, 0-1, 20-300 for cm 12-96 for inch, 0-4	 0 - crest length will be defined in cm 1- crest length will be defined in inch Crest length 0 – flow in cubic meter per hour 1 – flow in cubic feet per second 2 – flow in Gallons per minute

			3 – flow in liter per second 4 – flow in Million gallons per day
OCF ([17])	Rectangular contracted sharp crested weir	2, 0-1, 20-300 for cm 12-96 for inch, 0-4	 0 - crest length will be defined in cm 1- crest length will be defined in inch Crest length Flow units – see above
OCF ([17])	Trapezoidal (Cipolletti) sharp crested weir	3, 0-1, 30-300 for cm 12-96 for inch, 0-4	 0 - crest length will be defined in cm 1- crest length will be defined in inch Crest length Flow units – see above
OCF ([17])	V-Notch (Triangular) sharp crested weir	4, 0, 22.5 - 90, 0-4	 V-Notch angle in degrees Flow units – see above
OCF ([17])	Parshall Flume	5, 0-1, 15 - 360 for cm 6 - 144 for inch, 0-4	 0 - throat width will be defined in cm 1- throat width will be defined in inch throat width Flow units – see above
OCF ([17])	Palmer-Bowlus Flume	6, 0-1, 15 - 75 for cm 6 - 72 for inch, 0-4	 0- conduit diameter defined in cm 1- conduit diameter defined in inch Conduit diameter Flow units – see above
OCF ([17])	H-Flume	7, 0-1,	 0 - flume size will be defined in cm

			1 - flume size will be defined in inch
		15 - 135 for cm 6 – 54 for inch,	flume size
		0-4	Flow units – see above
OCF ([17])	Khafagi-Venturi Flume	8, 0, 12 - 160 0-4	 Flume width in cm Flow units – see above
OCF ([17])	Leopold-Lagco Flume	8, 1, 4 - 72 0-4	 Conduit diameter in inches Flow units – see above
OCF ([17])	Manning flow for circular pipes	9, 0-1, 0.000 - 1.000 0.000 – 0.200 15 – 900 for cm 6 – 350 for inch 0-4	 0 - pipe diameter defined in cm 1 – pipe diameter defined in inch Slope of pipe Roughness factor Pipe diameter in inches Flow units – see above
Reset, Verify Settings, ID, False Echo, Intermittent Echo, Gas Velocity			
RSD ([6])	Reset to factory defaults	None	
RSC ([6])	Reset hour counter	None	
RST ([6])	Restart Gauger	None	
STAT	Report settings	0	Send report to HyperTerminal
GMAN	Get Manufacturer data	None	Response is serial number and manufacturer date: dd-mm-yyyy
ENDT ([8])	Enable serial monitoring	None	
DSDT ([8])	Disable serial monitoring	None	
FES([19])	List fixed ultrasonic echoes	None	HyperTerminal will display a list of ultrasonic echoes – see ([19]).
FES([19])	Set fixed echo as false	0-5	Index of echo ([19])
FILT	Ignore intermittent echo	0 - 20	0 - do not ignore intermittent echoes 1 - Ignore short duration echoes … 20 – Ignore long duration echoes

GCOF	Gas Velocity Coefficient	0.3 – 5.0	Speed of sound in the measurement area is higher by this multiplicative coefficient.

All notes are explained in section 5.5

5.5 Notes

Note #	See detailed information in Reference guide chapter…
([1])	Section: “Application type”
([2])	Section: “Application dimensions and constraints”
([3])	Section: “Distance units and value to display“
([4])	Section: “Filling rate”
([5])	Section: “Temperature sensors, units and temperature display”
([6])	Section: “Reset and operating hours”
([7])	Section: “Volume measurement”
([9])	Section: “4-20 communication”
([10])	Section: “HART communication”
([17])	Section: “Open Channel Flow”
([18])	Section: “Gas Velocity Coefficient”
([19])	Section: “False Echo Scan by PC”

6. Some useful examples

6.1 Basic setup

$RSD $	Reset to default
$VAL 1 $	Value to display is LEVEL
$UNT1 $	Unit system is metric
$APP 0 $	Application is high power
$EMP 8.0 $	Distance to empty level is 8 meter
$FUL 0.15 $	Distance to full level is 0.15 meter
$VAL 1 $	Value to display is level

6.2 Advanced setup

$RSD	Reset to default
$VAL 1 $	Value to display is level
$UNT 1 $	Unit system is metric
$FBD 8.0 $	Far blocking distance is 8 meters
$NBD 0.4 $	Near blocking distance is 0.4 meter
$RAT 3 $	Tracking rate is 10 meters per minute
$TMP 3 $	Temperature unit is Celsius
$SNS 0 $	Temperature sensor is the internal
$CYLV 5.0 , 2.0 $	Tank is vertical cylindrical, height 5m and diameter 2m
$TWOW 0.0 , 15700 , 20 , 2 , 1 $	4mA represents 0 liters, 20mA represents 15700 liters, error is represented by 22mA

Note: Always verify then re-verify that your basic settings are correct including distance to empty level, distance to full level, level or distance choice. Most wrong readings originate from incorrect setup.

VI. Firmware upgrade tool

1. Introduction

Gauger420 firmware can be upgraded in the field. The upgrade procedure takes less than 5 minutes but should be done carefully to avoid damage to the system. This feature is useful for adding new features to your Gauger420 system and for fixing bugs.

- Perform firmware upgrade only when authorized to do so by the manufacturer or re-seller.
- While upgrading **Gauger420**, record your steps and also record any messages that appear on-screen. This will aid in troubleshooting a defective upgrade process.
- Most stored settings will usually not be lost when upgrading the firmware.
- Use only the updated firmware provided by the manufacturer or re-seller.

2. You will need

(a) PC with minimum requirements: Windows XP Service Pack 2 or Windows7/16 bit, CD drive USB port and administrator rights. The firmware upgrade tool was also tested on Windows7/32 bit.
(b) **Gauger420** Installation CD.
(c) New **Gauger420** firmware which is authorized for upgrading your **Gauger420**.

3. Installation of Firmware Upgrade Tool and USB driver

(a) Insert the installation CD, select and run Setup.exe in the main directory of the CD.
(b) Follow the on-screen instructions. When prompted for an installation directory, keep the default installation directory: "c:\program files\solidat\GaugerFirmwareUpgradeTool" or choose another directory.
(c) When complete, check for new icon on your desktop and new program entry in the programs list.
(d) Install Gauger420 USB driver by following instructions in chapter: "USB driver installation on a PC".

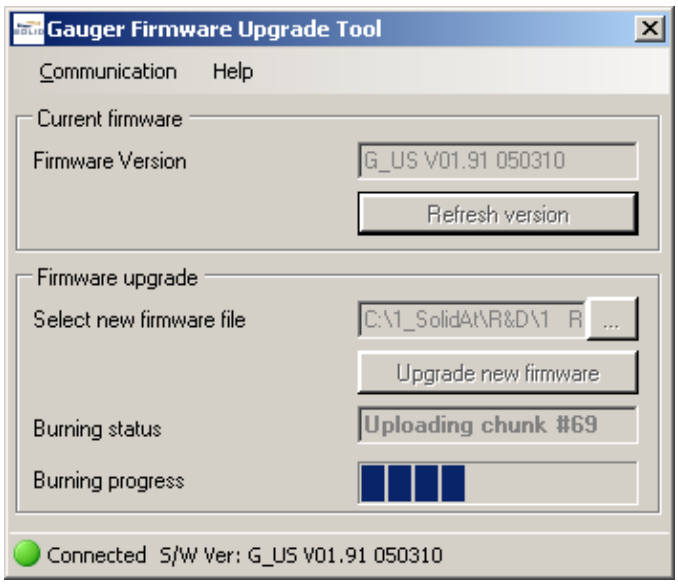
4. Upgrade procedure

(a) Copy the new **Gauger420** firmware (e.g. xyz.bin) to a directory of your choice.
(b) Run Gauger Firmware Upgrade Tool by clicking on the proper desktop icon.
(c) Wait until the proper COM port is identified (the port connected with **Gauger420**) then press OK on the pop-up window.

Verify that current firmware version is displayed on the top line.

(d) Click on the "…" button, browse and select the new firmware (e.g. xyz.bin). When the new name appears on the windows, you can press the "upgrade new firmware" button. Follow the progress and instructions on-screen. After some while, **Gauger420** display will be turned off – this is normal.

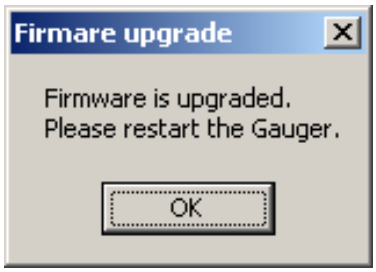
During the upgrade, you will see a progressive bar on the window as follows:



Be patient!

If you do not see the bar starting, or if the bar has stopped moving – just wait! If you disconnect the Gauger while in the middle of the upgrade process, the internal software may be impaired and may require returning to the factory. If the bar has not started or has stopped, wait for at least 10 minutes before reconnecting and restarting the process.

(e) Wait for the upgrade process to complete. The process is complete when you see the following window:



Now click OK and Restart **Gauger420**.

5. Troubleshooting the firmware upgrade process

Symptom	Recommendation
Installing Upgrade Tool	
Installation of the upgrade tool halts due to .NET Framework missing.	Install .NET Framework on you PC (2.0 or above). See http://www.microsoft.com/downloads/details.aspx?familyid=0856eacb-4362-4b0d-8edd-aab15c5e04f5&displaylang=en
Installation of the upgrade tool halts due to user permissions	Verify that you are a local administrator on the PC.
Upgrading the firmware	
COM port is not found Or current firmware version is not displayed	(1) Make sure **Gauger420** is turned on. Disconnect and then connect again the USB cable. (2) Select the Communication tab. Try automatic port selection then try manual port selection. (3) Shut off the Upgrade Tool then verify with the Windows Task Manager that a Gauger process is not running. Run the Upgrade Tool again.
Upgrade process has halted	Wait for 10 minutes. Restart the application. Restart you PC and try again.
Gauger420 display stays blank after installation and restart	Restart your PC and try again.

VII. Serial data monitoring

1. Introduction

GaugerGSM may be monitored locally. Gauger420 may be configured to send information to a PC over the RS485 interface (for models supporting RS485) and that information may be viewed with a HyperTerminal application. This feature is useful for field monitoring and for debugging purposes. Information being sent by Gauger420 includes measured data such as Distance and Temperature and internal system variables.

2. Installation and operation

(a) For monitoring over RS485, install the USB driver for Gauger420 as described in the chapter: "USB Driver installation on a PC". You may have done so already for the "PC configuration utility" or for the "Firmware upgrade application". In that case, there is no need to do it again.
(b) Connect **Gauger420** to your PC using a RS485 cable.
(c) Launch the HyperTerminal application on the PC. To do so, follow the instructions included in the chapter "Configuration with a PC" under the sub-section "Launching and setting up HyperTerminal".

> The settings of HyperTerminal for configuring GaugerGSM and for serial monitoring are identical except for the item "Append Line Feed". When monitoring, you should uncheck the "Append Line Feed" item in the ASCII setup to avoid extra lines.

(d) Information may be simply viewed or gathered into a text file by using the Transfer /Capture Text tab of HyperTerminal. This file may be requested by SolidAT for debugging purposes of some challenging installations. You can define this file as txt or csv. You can also define the file as txt and later rename it to csv. A csv file can then be conveniently viewed with an excel application.

3. Record format

Record format is different in various firmware versions. Call the manufacturer for details. A typical record on the HyperTerminal screen or text file may appear as follows:
220, 1.532, 1.531, 2, 1, 32, 67

A csv file will appear as follows:

220	**1.532**	**1.531**	**2**	**1**	**32**	**67**
Index		**Distance**				

In these recordings the third column from the left is the measured distance data. The first column from the left is a running index. Other columns are internal equipment variables applicable for manufacturer debugging purposes. Fields may change between software versions. Check with the manufacturer about the fields in your recording.

VIII. USB Driver Installation on a PC

This chapter describes the installation of Gauger420 USB drivers on a PC. The driver installation is required when using the PC / Laptop for:

- Configuration of Gauger420
- Serial monitoring
- Firmware upgrade

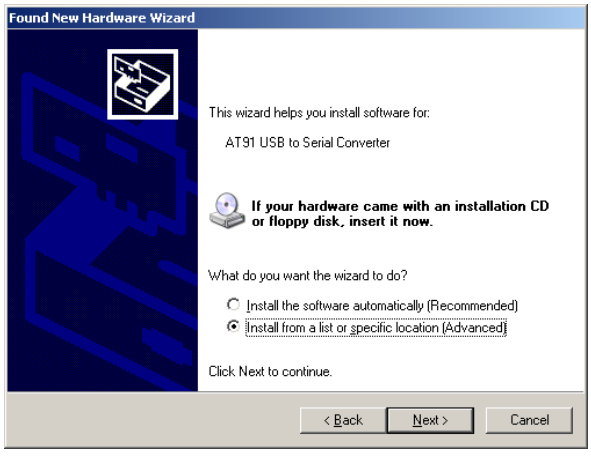
The drivers were tested on XP Windows and Windows 7/32 bit systems.

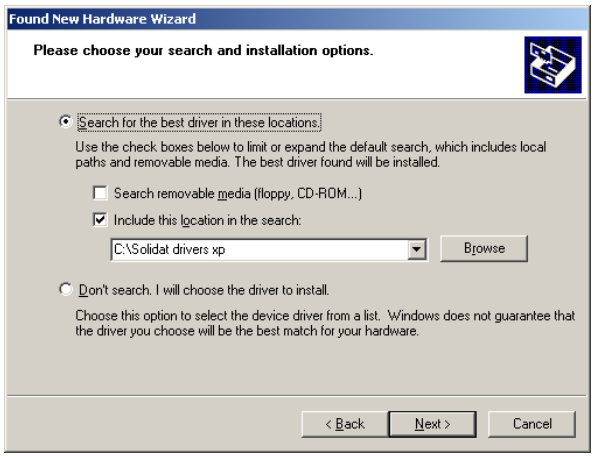
(a) Copy the directory “SolidAT Drivers XP” from the CD to your PC.

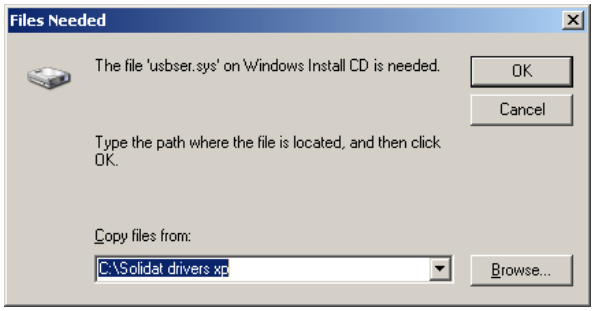
(b) Connect the PC to **Gauger420** using a USB cable. Keep cable length to less than two meters. Turn **Gauger420** on (if not already powered by the USB).

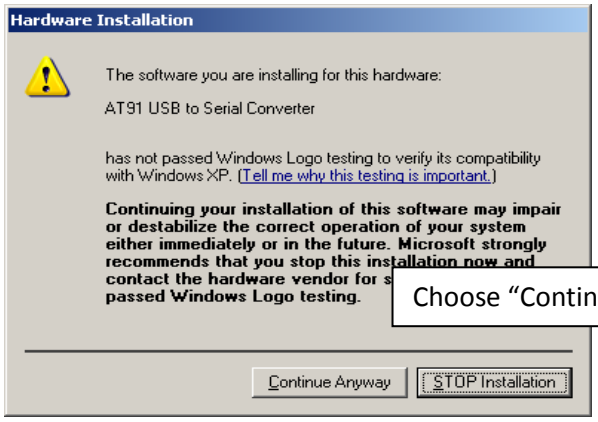
(c) Follow the standard driver installation instructions on the PC. Whenever prompted for a driver, select the location of “SolidAT Drivers XP”.

(d) The following set of windows may aid you when following with the installation.



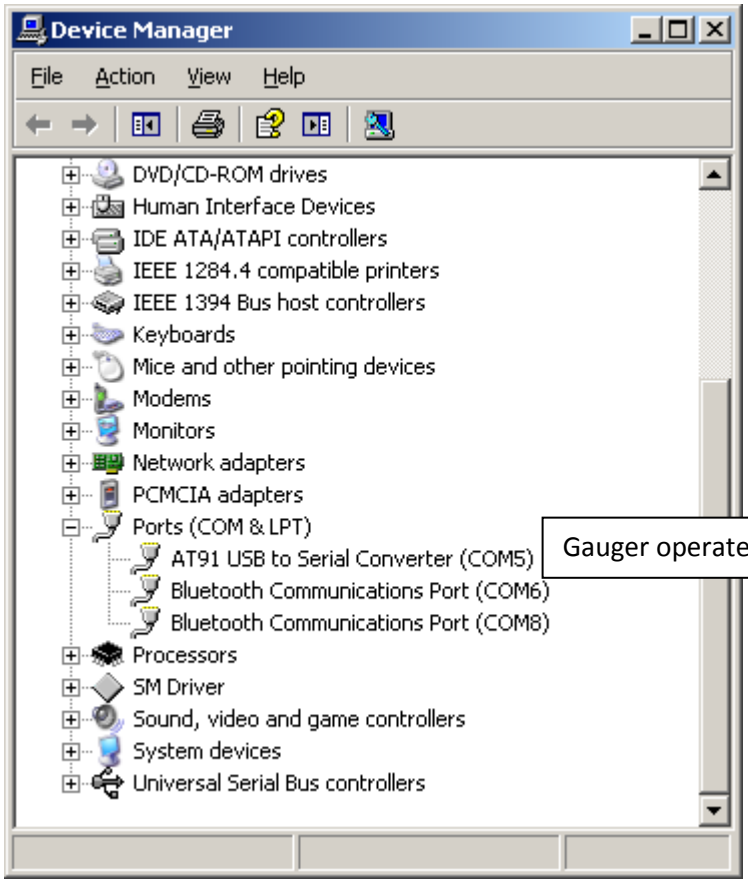






Choose “Continue Anyway”…

You should also check proper installation by viewing the device manager:



Gauger operates with USB to Serial (COM 5 in this case)

If the USB driver installation failed, a "?" sign may be listed at the "Ports" item. In other cases, the driver may be listed under "Other Devices" item. In both cases, uninstall the device and than re-install it again.

IX. Reference Guide

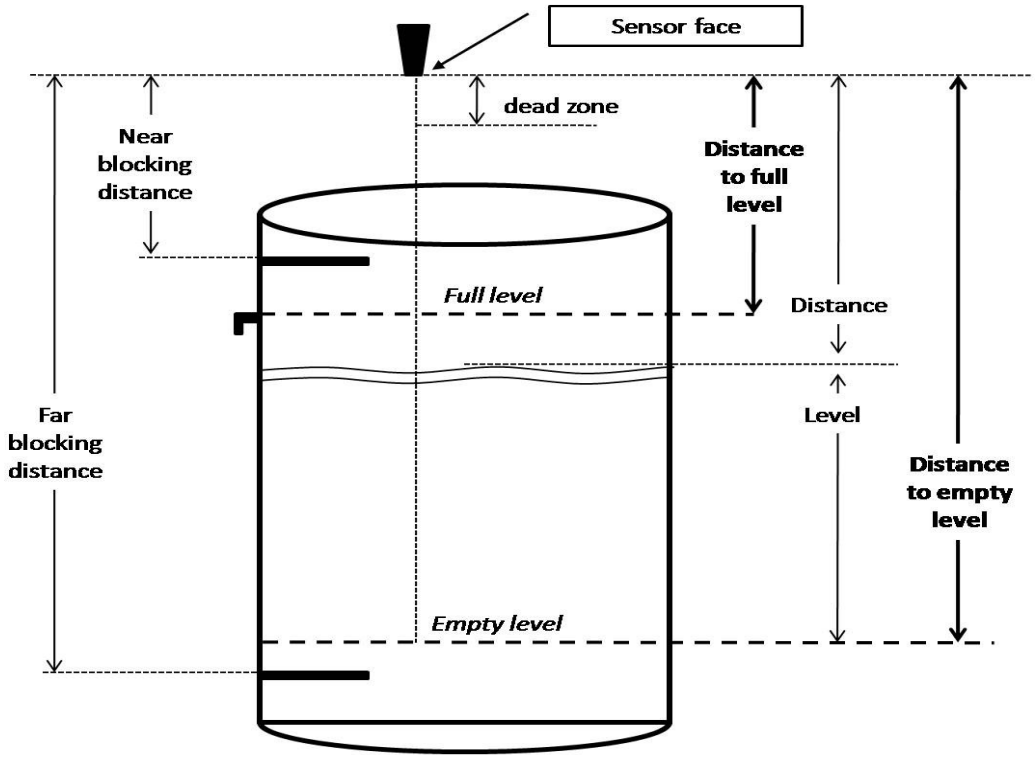
Application dimensions and constraints

(a) Basic dimensions

Basic variables include:

- Distance
- Level
- Dead zone
- Full level
- Empty level
- Distance to full level
- Distance to empty level
- Maximum range
- Near blocking distance
- Far blocking distance

These variables are shown on the following figure along with the "**fundamental interdependency equation**".



15 cm = Dead Zone < NBD < Full < Empty < FBD < Maximum range = 8 meter

Figure 18 - Application dimensions (for 75 KHz sensor)

See also the section "Interdependencies" in this chapter and the section "4-20 communications (d) 4-20 default settings" later in this chapter.

(b) Distance to empty level

Distance to empty level is defined as the distance from the face of the sensor to the bottom-most surface of the target to be measured. For typical installation in tanks, the bottom-most surface is usually the bottom of the tank.

Gauger 75 KHz supports a maximum range of 8 meters and the default value for distance to empty level is 8 meters. The user is cautioned however that the maximum practical range depends on target characteristics. Range of 8 meters may be achieved with quiet liquid surface targets. As a rule of thumb, user no more than 5 meters for solids, turbulent liquids, when the air medium is not clear or when interferences exists. You may verify proper operation by checking whether the equipment frequently enters a state of "echo search" at your maximum distance.

When the Gauger enters the empty level, it will present an empty status on the display. The Gauger will exit this state when level rises at least 2cm above the empty level.

(c)Distance to full level

Distance to full level is defined as the distance from the face of the sensor to the top-most surface of the target to be measured. The default value for distance to full level with 75 KHZ sensor is 15cm. This is also "dead zone" of the Gauger and cannot be reduced under any circumstances.

The user is cautioned to prevent targets from crossing this limit as this may result in unpredictable measurements. You can overcome this limitation by proper installation. For example, if the target can approach the tank roof, install the Gauger on top of an extension pipe which is at least 15cm long.

When the Gauger enters the full level, it will present a full status on the display. The Gauger will exit this state when level decreases by at least 2cm below the full level.

(d) Far blocking distance

Gauger normally measures distance to targets which are closer than the "Empty level".

In some circumstances, the Gauger might detect an echo which is further out than the "Empty level". This echo may be the result of the actual target below the empty level or a strong interference below the empty level. In such cases, Gauger would report "Empty" and would transmit an SMS to report the event. If you expect echoes further out than the empty level, and you prefer to avoid these event reports, you can define a Far Blocking Distance (FBD). Once defined, the Gauger will completely disregard any echoes beyond the FBD. If no other echoes closer than FBD are detected, the Gauger will report lost of echo.

The default for "Far Blocking Distance" is identical to the distance to maximum range of the Gauger.

(e) Near blocking distance

If distance between the sensor face and the topmost level of the target is larger than the specified "dead zone" by at least 5cm, you should consider defining a Near Blocking Distance (NBD). The NBD should be defined as 2-3 cm shorter than the distance to the topmost level. This will ensure that the Gauger will not measure obstructions slightly above the topmost level and report them as full level.

Similarly, when an extension pipe is used, and the length of the extension pipe is larger than the "dead zone", you should define NBD which is larger by 2-3 cm than the length of the extension pipe. This will ensure that you will not pick up echoes arising from the bottom end of the pipe and report them as full level. If no other echoes further than the NBD are detected, the Gauger will report lost of echo. The default for "near blocking distance" is identical to the distance to "Dead Zone".

Application type

Application allows some tuning of the internal Gauger algorithm to be tuned to the application. The application may be selected as low power or High power. Always use low power for stable measurements unless your target appreciably attenuates the echo such as: powder solids, liquid with foam or long extension pipes.

Default values

Gauger*420* is preset by the manufacturer to a set of default values. The user may revert at any time to these default values by performing the reset-to-default operations as described in the section: Device state. Changes to the values made by the user will remain intact (survive equipment on/off) only after the user returns to the measurement screen.

The table below defines the default values for Gauger-75 KHz. A default value may automatically change in response to a change in some other value. For example, 20mA default value after setup is 7.85 (+/- 0.001) meters. This value assumes an empty level at 8.00 meters and a dead zone of 0.15 meter. If empty level is modified to 5 meters and NBD is modified to 1 meter, the 20mA value will automatically change to 4 meters.

Parameter	Default Value
Distance Unit	meter
Application	Low power
Empty level	8.000 meter
Full level	0.150 meter
Value to display	Distance
FBD	8.000 meter
NBD	0.150 meter
Filling rate	5 m/min
Temperature units	Celsius
Temperature sensor	Internal

4-20 representation	Level
4mA settings	0 meters
20mA setting	7.85 meters
4-20 fixed current	15mA
HART address	0

Distance units and value to display

Either meter or feet may be selected for the distance unit. This selection defines the complete unit system being used by the Gauger. Selecting meter as your distance unit implies the Metric unit system. Selecting feet as your distance unit implies the Imperial (US / American) unit system. Distance units can only be modified with the PC configuration tool with the command: UNT.

The Gauger built-in display may be configured to display different variables. Distance and level may always be selected as the variable to be displayed. When tank shape and dimensions are defined, the Gauger may also be set to display volume of the target. Volume display may be turned on with the PC configuration tool using the VAL command. Distance or level may be set from the keypad or from the PC configuration tool.

False echo scan by Keypad

False echo scan by keypad is a procedure for identifying and extracting fixed obstructions nearby the target or sensor. This procedure should be performed when the tank is empty. The procedure is initiated from the keypad only. Further information is provided in the chapter describing configuration with a keypad/display under the basic setup option. The feature is not available in models without display. False echo scan by PC is a preferred method for handling false echoes.

False echo scan by PC

False echo scan by PC is a procedure for identifying and extracting fixed obstructions that may mask proper measurement. Follow these steps:
(1) Install the Gauger at its intended location. Perform command RSD.
(2) Perform command FES and wait for a few seconds. HyperTerminal should display a list of echoes. Each echo is presented by one line, displaying its distance and status. Status may be 0 or 1. “0” refers to a legitimate echo and “1” refers to a false echo. The first FES command after RSD should show “0” status for all echoes.
(3) Select an echo that represents an obstruction. Find the index of this echo by counting the list of echo lines. The index of the echo on the first line is 1, the index of the echo on the second line is 2 and so on. Perform the command FES X where X is the index.
(4) Perform the USB command RST.
(5) Repeat steps (2) through (4) if necessary to define false echoes.
By the end of this procedure, the Gauger should ignore echoes which were defined as false.

Filling Rate

Filling rate allows you to tune the tracking of Gauger to fast moving targets. You should increase the filling rate figure if your target fills up or drains down rapidly. Always use the lowest possible filling rate in order to preserve accuracy of the measurement. A high filling rate will allow better tracking before lost of echo when the target moves rapidly. Nearby full (empty) levels, the tracking rate is reduced to avoid erratic entry into full (empty) level.

Gas Velocity Coefficient

Distance and level are derived by multiplying the delay of ultrasonic echo by the velocity of the ultrasonic pulse in air (close to speed-of-sound). In a gas environment which different than air, the velocity of the ultrasonic pulse is also different.

If velocity in the gas environment is twice as high as the velocity in air, a Gas Velocity Coefficient of 2.0 should be configured within the Gauger using the GCOF command. Similarly, if the velocity in the gas environment is half the velocity in air, the GCOF coefficient is 0.5.

Speed of sound at different gasses and mixtures can easily be found in physical and engineering textbooks and internet sites.

HART communications

HART is a standard digital communication protocol carried by the two power lines of **Gauger***420.* When using HART communications make sure that the voltage on Gauger420 port is at least 14VDC. *,* The protocol can provide information on four different Measurands which may be selected at setup. HART may be used as a bus protocol allowing up to 16 devices on the same bus, each identified by a unique address.

HART parameters may be set using the PC configuration option. The setup provides for:

- Determining the four Measurands (PV, SV, QV and TV)
- Determining the **Gauger***420* address

Some notes for HART configuration.

- Support for HART depended on firmware version.
- Guidelines related to the configuration of PV, SV, TV and QV using the PC:
  (1) Value 3 is Temperature as defined in SNS and may not be used by PV.
  (2) Values 2 and 6 may be selected only if VAL=3 or 6.
  (4) Each of PV, SV, TV and QV must be unique.
- HART should be configured after configuring all other settings. IF EMP or FUL are modified then HART configuration will be reset to the default values. Default values are defined at the EMP and FUL levels.

Interdependencies

For Metric units

	Applicable to items	Interdependencies
1	EMP, FUL, NBD, FBD	**0.15 ≤ NBD ≤ FUL ≤ EMP ≤ FBD ≤ 8.000**
2	VAL=3,6	One and only one of the following must be configured: CUB, CYLH, CYLV
3	TWOW	*When representing Level:* **0 ≤ Level represented by 4mA ≤ Level represented by 20mA ≤ (EMP-FUL)** *When representing Distance (reverse Level):* **FUL ≤ Distance represented by 4mA ≤ Distance represented by 20mA ≤ EMP** *When representing Volume:* **0 ≤ Volume represented by 4mA ≤ Volume represented by 20mA ≤ Volume at level of (EMP-FUL)**

For American units

	Applicable to items	Interdependencies
1	EMP, FUL, NBD, FBD	**0.50 ≤ NBD ≤ FUL ≤ EMP ≤FBD ≤ 26.00**
2	VAL=3,6	One and only one of the following must be configured: CUB, CYLH, CYLV
3	TWOW	*When representing Level:* **0 ≤ Level represented by 4mA ≤ Level represented by 20mA ≤ (EMP-FUL)** *When representing Distance (reverse Level):* **FUL ≤ Distance represented by 4mA ≤ Distance represented by 20mA ≤ EMP** *When representing Volume:* **0 ≤ Volume represented by 4mA ≤ Volume represented by 20mA ≤ Volume at level of (EMP-FUL)**

Open Channel Flow (optional feature)

Open Channel Flow refers to the flow of water or wastewater in natural channels such as rivers or in artificial channels such as irrigation ditches. Under some conditions, fluid level in the channel (in units of meters or feet) can be mapped to flow (in units of cubic meter per hour, gallons per minute etc).

Typically, flumes or weirs are constructed in the channel to allow calculation of flow from level. Flumes and weirs are structures that introduce a well-designed obstacle to the fluid flow causing a measureable

increase in the fluid level nearby the obstacle. This level increase can be measured to obtain flow using hydrological formulas or empirical equations.

Several different designs of flumes and weirs are applied world-wide. GaugerGSM implements flow equations for nine different designs:

- Rectangular suppressed sharp crested weir
- Rectangular contracted sharp crested weir
- Trapezoidal (Cipolletti) sharp crested weir
- V-Notch (Triangular) sharp crested weir
- Parshall Flume
- Palmer-Bowlus Flume
- H-Flume
- Khafagi-Venturi Flume
- Leopold-Lagco Flume

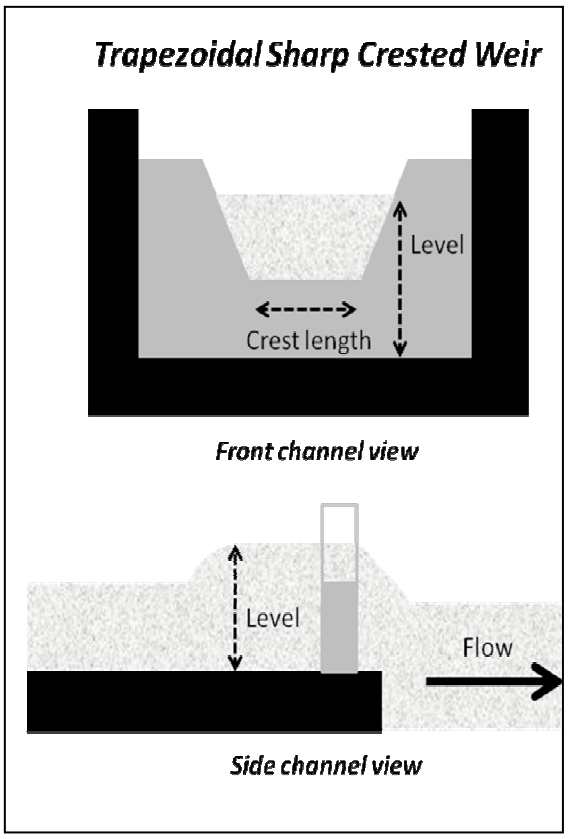


Figure 19 - OCF weir example

For each design GaugerGSM supports a range of sizes which usually represent the obstacle size within the structure (crest length in weirs or flume throats). These sizes can be defined in either cm or inches.

The calculated flow may be obtained in one of the flowing units:

- Cubic meter per hour (M3H)
- Cubic feet per second (CFS)
- Gallons per minute (GPM)
- Liter per second (LPS)
- Million Gallons per day (MGD)

Additional flume and weirs as well as additional flow units may be added to GaugerGSM upon request.

When no flume or weirs are present within the channel, the Manning Formula may be applied: http://en.wikipedia.org/wiki/Manning_formula. With this formula, flow may be calculated if certain

characteristics of the channel are known. Specifically, channel cross section shape and size, channel slope along the flow and roughness coefficient. GaugerGSM implements the Manning Formula for channels in the shape of pipes (e.g. semi circular cross section).

GaugerGSM is setup for a specific flume, weir or Manning circular pipe by using a USB command. See chapter “Configuration with a PC”.

Reset and operating hours

Gauger420 may be reset to their factory defaults. This operation may be preformed from the keypad or from the PC configuration tool (command RSD). Once executed, the Gauger will return to the state as delivered from the factory. Gauger420 may also be reset to restart without any change in the pre-configured parameters (command RST).

Gauger420 keeps track of two counters for measuring operating hours.

- Non resettable counter (Odometer principle)
- Resettable counter (Trip-meter principle)

The non resettable counter displays the total hours of operation since the system is out of the factory. This counter aids both manufacturer and user in keeping track of specific Gauger420 history. The resettable counter displays the total hours of operation since the recent turn-on of the equipment or since the last reset of this counter. This counter aids the user in keeping track of the equipment for maintenance and other operations. The resettable counter may be activated from the built-in display or using the PC command RSC.

Temperature sensors, units and display

Gauger systems implement automatic compensation of deviations due to temperature variations in the air temperature of the ultrasonic media. The temperature is sensed by a temperature sensor which is embedded within the acoustic sensor. In installations where temperature varies very rapidly in time and location, it may be preferable to install an external temperature sensor which will follow more closely the varying temperature.
For these installations you can select the internal embedded temperature sensor or the external temperature sensor (if one is connected) or average both readings. Physical connection and installation of the external temperature sensor is described in the chapter physical installation guidelines. Temperature units may either be selected as Celsius or Fahrenheit. Temperature may be viewed on the built-in display. Temperature readings on the display present the following table:

Sens:	Cur	High	Low
Int	29.5	31.0	26
Ext	29.4	32	23.3

Reset Done

Figure 20 - Temperature readings

The second line displays temperature measured by the internal temperature sensor. The third line displays temperature measured by the external temperature sensor. The column “Cur” displays the current temperature while “High” and “Low” columns display the highest and lowest temperature ever recorded by the temperature sensors since the last reset was performed.

Volume measurement

(a) General

Based on measured Level, tank shape and tank dimensions, Gauger420 can calculate and report Volume rather than Distance or Level. Configuration of Volume elements can only be executed using the PC configuration method.

Currently, three tank shapes are supported:

- Box shaped
- Horizontal cylindrical tanks with curved or non-curved sides
- Vertical cylindrical tank with curved or non curved bottom-side

(b) Box shaped

Two horizontal box dimensions should be configured (X, Y), allowing Volume calculation of the liquid contained within the box shaped tank. The third dimension is the level measured by the Gauger (Z).

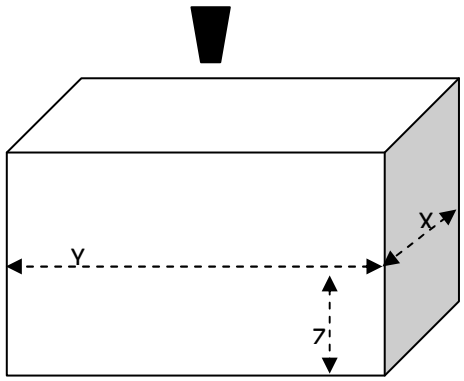


Figure 21 - Box shaped tank

For advanced users

The box shaped tank may also represent any other tank if Volume (V) and Level (L) are linearly related in that tank. Mathematically stated, if V = k * L where k is a constant. For such a tank, enter X=1 and Y=k.

(c) Cylindrical tanks

Horizontal cylindrical tank with curved sides:

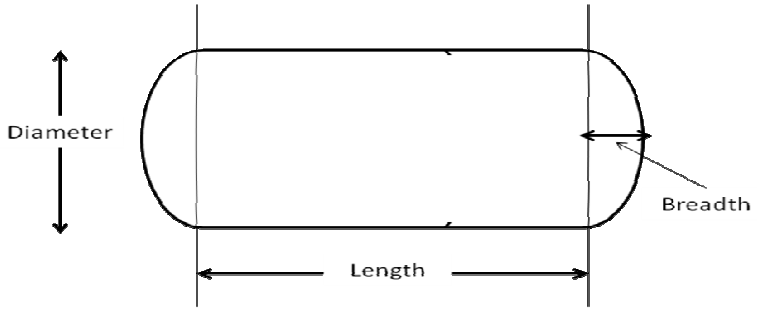


Figure 22 - Cylindrical horizontal tank

The breadth may be zero for straight ends.

Vertical cylindrical tank with concave bottom:

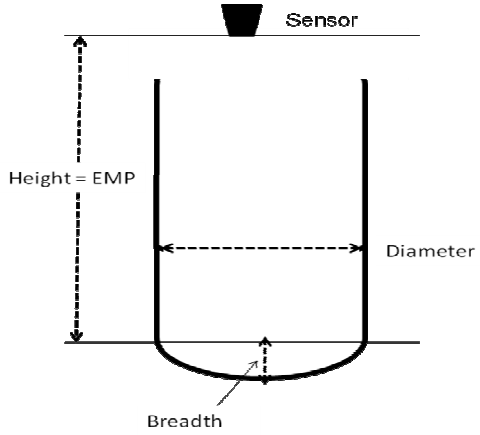


Figure 23 - Cylindrical vertical tank

See also the section: “Interdependencies” in this chapter.

4-20 communications

(a) 4-20 Setup

Gauger*420* is powered by two-wires which also carry measurement information. Measurement related information is conveyed by current magnitude which may take any value between 4mA and 20mA.

During setup, the user determines:

- The measurement value represented by 4mA
- The measurement value represented by 20mA
- The current value representing an error

The current may represent one of the following Measurands:

- Level
- Distance
- Volume

In addition, the current may be set at some fixed value thereby not carrying any measurement information.

An error state (echo is lost for at least 3 minutes) may be represented by one of the following:

- 3.6mA
- 22mA
- Holding the most recent legal value
- 3.6mA or 22mA, the one nearest to the most recent legal value

Pressing any keypad button will cause the current to jump 22mA regardless of the 4-20 error settings. The current will return to represent measurement as soon as the device resumes normal measurement

The current read by the user should be interpreted as follows:

$$Measurement..value =$$
$$....\{value..represented..by..4mA\} +$$
$$.....\{value..represented..by..20mA - value..represented..by..4mA\} *$$
$$.....(current[mA] - 4)/16$$

Setup may be performed using the keypad or by PC configuration. Each is described in the appropriate chapter of this user manual.

The reader is further advised to review the interdependencies section in the PC configuration chapter.

(b) 4-20 Performance

When **Gauger***420* is fed by low current, the performance of the system is modified to accommodate for the available electrical power. In particular, the rate of ultrasonic pulse transmissions is decreased. This decrease means that **Gauger***420* response to rapidly moving targets is reduced. At low current and low voltage the pulse rate may be four times lower than the maximum rate.

(c) 4-20 constraints

4-20 settings must be configured after settings of Full and Empty levels. Once Full and Empty levels are configured, 4-20 settings are modified to their default values. For other constraints related to 4-20 setting please refer to the Interdependencies section.

(d) 4-20 default settings

Default settings when measuring level

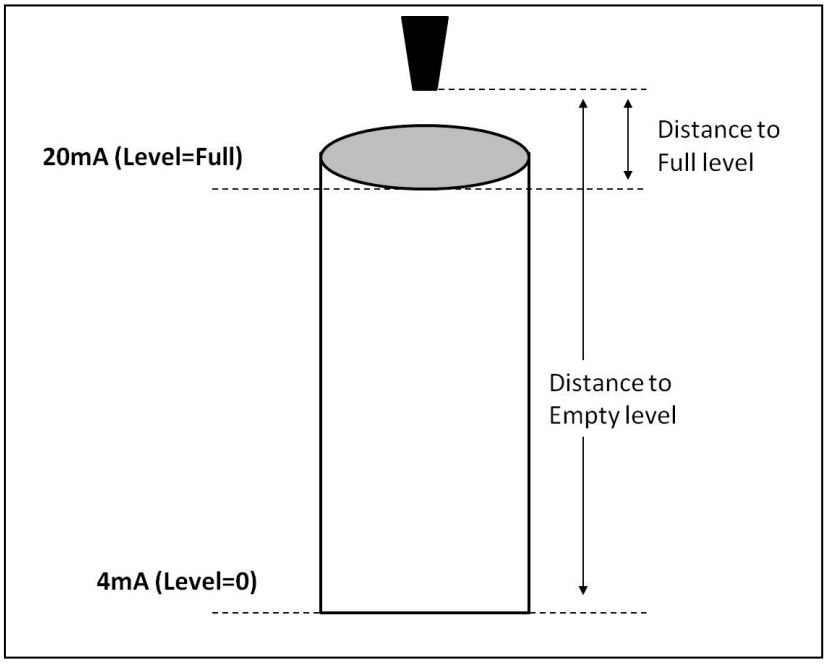


Figure 24 - Default 4-20 values for Level

Default settings when measuring Volume

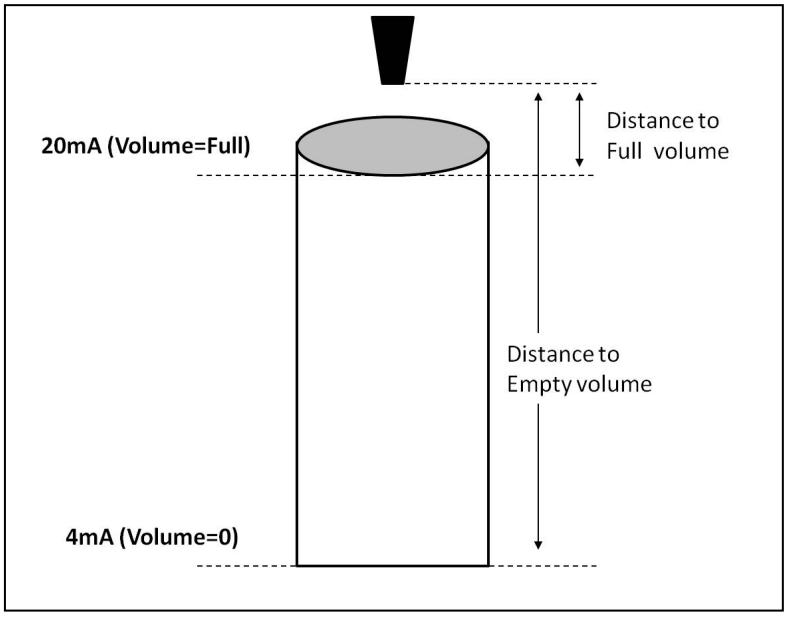


Figure 25 - Default 4-20 values for Volume

Default settings when measuring Distance

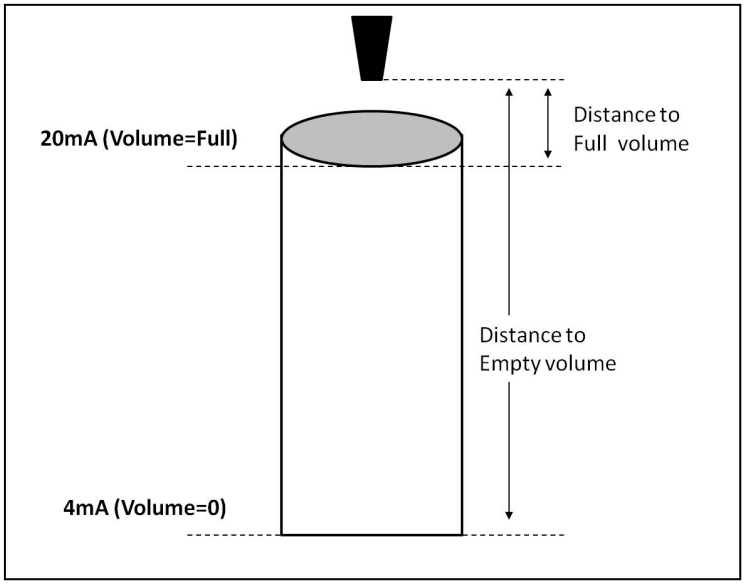


Figure 26 - Default 4-20 values for Distance

X. Troubleshooting

Symptom	Recommendation
Power On faults	
Gauger*420* does not power on	1. Check the rating of your power supply and verify these ratings are within the specifications of the **Gauger***420*. 2. Check the electrical cables between the power supply and the Gauger. In particular, check the connections on the **Gauger***420*.
Gauger*420* powers on but does not measure	1. Check the rating of your power supply and verify these ratings are within the specifications of the **Gauger***420*. 2. Check if a USB connection powers up the **Gauger***420* – do not use a USB connection to power up the **Gauger***420*.
Ultrasonic related faults	
Status line 1 reports constant ECHO SEARCH	1. Check your target is between 15 cm and 8 meters (6 meters for solids). 2. Verify that the sensor is precisely directed towards the target. 3. Check the sensor face and make sure the face is clear of dust or dirt. 4. If you use an extension pipe, recheck all the recommendations stated in the extension pipe section in this manual.
Level measurement is incorrect	1. Check that distance measurement is correct. Verify the settings of Full level and of Far Blocking Distance.
Level measurement displays Full level continuously	1. Check and clear out physical disturbances above the empty level. 2. If you are using an extension pipe, increase NBD to a distance which is 2-3 cm beyond the edge of the pipe.
4-20 related faults	